Education and Technology Series

CASE STUDIES OF MICROCOMPUTERS IN THE CLASSROOM

Questions for Curriculum and Teacher Education

JOHN OLSON, Principal Investigator
SANDRA EATON

This research project was funded under contract
by the Ministry of Education, Ontario.

It reflects the views of the authors and
not necessarily those of the Ministry.

The Honourable Sean Conway, Minister
Bernard J. Shapiro, Deputy Minister

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ABSTRACT

How are microcomputers being used in the classroom? Why do teachers use them in the ways they do? These are some of the questions we have tried to answer in the report of a twelve-month project funded by the Ministry of Education.

The report presents the teachers' perspectives on innovation. Teachers participating in the project identified several factors that influenced how they used microcomputers: the support they received; private and public expectations for the school; ministry and school board guidelines; and the rather unique process of "grassroots" innovation in which they were involved.

Working with eight schools and from grades four to ten, we compiled a series of case studies that document in detail both how and why teachers use computers. Although we chose schools that collectively offered us a wide range of computer applications -- using the computer for graphics, for geographical simulations, for special education, for French immersion, for core French, for example -- the eight studies fell equally into two distinct groups -- one in which computers were part of a "literacy" program, and another in which computers were used as a teaching tool. We found both uses to be important to teachers.

The report uses these case studies to compare and contrast the curriculum and professional development issues, associated with the two groups of computer use, that emerged from our visits to classrooms and our conversations with teachers and students. We hope that teachers, administrators, and policy makers will find useful information in the documentation of these cases and insights into the problems that face innovators in this field in our analysis of the cases.

Topics that we think will interest readers include: the rewards teachers find in innovation in spite of the difficulties; how classroom routines can be adjusted to cope with the problems presented by the use of computers; where the limits of innovation are for different teachers; the support teachers want to help them adjust to new ways of doing things; the trade-offs that exist when new ways of doing things conflict with well-established and effective routines; and what students can gain from new technologies in the classroom and how that affects their teachers.

The study reflects a way of looking at innovation that stresses the view from the classroom and uses that point of view to suggest approaches to professional development that are sensitive to the concerns of teachers, that respect what teachers have to cope with, and that try to understand how they set out to accomplish their goals.

PREFACE

How are computers being used in the classroom? Why do teachers use them in the ways they do? These are the questions we have been asking in the "Microcomputers in the Classroom" project, which has investigated how teachers are responding to computer innovation in the classroom.

The teachers participating in the project identified several factors as influential in determining how computers are incorporated into classroom routines: environmental factors, private and public expectations for the teacher and the school, ministry and board mandates, and the rather unique process of innovation in which the teachers themselves were involved. Although such factors were common to the situations we investigated, two distinct patterns of computer use emerged -- computer as subject and computer as instructional tool.

Working with eight schools, across divisions, we compiled eight case studies that document in detail both how and why individual teachers use computers. All schools were from the same board. This board has encouraged computer innovation by installing a single computer system in each school (keyboard, green and colour monitor, single or double disk drive, possibly a printer) and by initiating a pilot project scheme in which teachers interested in having a classroom computer were invited to submit a project application containing formal objectives and methods of evaluation. All the schools we investigated had been awarded computers under this scheme, usually a single system but in two cases a distributed lab of ten computers.

The general computer situation in each school was ascertained through a preliminary interview with the school's principal or computer co-ordinator. The teachers' perceptions of the contextual factors influencing their classroom practice and their theories about computer use were obtained through a series of interviews. Their practice was captured through videotaping, through their analysis of various computer situations using the repertory grid technique, via a computer use journal each was asked to keep, and through lists of software they reported using. These instances of practice then became the basis for further interviews. (These techniques are described in more detail in appendix B.)

Although we had chosen computer projects that seemed to offer a wide range of applications -- using the computer for creative writing, film-making, graphics, geographical simulations, special education, a French immersion program, and junior core French -- the eight case studies fell equally into two distinct groups: those in which "doing computers" had become a new school subject, and those where the computer was being used as an instructional tool for other subjects. These two patterns of use differed in goals, learning potential, demands on the teacher, pedagogy, and curriculum implications. Of the two, we found "doing computers" the most problematic because of its newness and uncertain status as a subject.

In chapter 1 we describe four cases in elementary schools in which the computer is being used as the focus of a new school subject, sometimes called informatics or computer studies. In chapter 2 we describe four cases in which the computer is being used as a teaching aid within existing teaching areas of the school. In chapter 3 we analyse the data we have collected and in chapter 4 we look at what we can learn from the study that might be helpful to those who have responsibilities for curriculum development and teacher education.

Attached to the report are the case studies (appendix C) and our research methodology (appendix B). We hope that readers will become familiar with the cases early on in their study of the report. It is from these cases that we have launched our interpretive efforts that culminate in our discussion in chapter 4 of the practical consequences of this study.

CHAPTER 1: DOING COMPUTERS AS A SUBJECT

INTRODUCTION

In this chapter we are concerned about a number of interrelated issues. First, how do teachers fit teaching the computer as a subject into their existing practices? Second, how do they explain why they are doing things as they are? Third, what experiences with computers have been significant in forming their approach to using computers? As we deal with these questions we hope to begin to fit the pieces together in order to make sense of these practices in terms of the teachers' purposes.

There are ways of treating the cases together for the purpose of answering these questions. First, in four schools -- Bathurst, Ellesmere, Wolsey, Marlborough[1] -- computers are being used to teach a new subject called by the teachers "computer awareness" (see tables 1 and 2). We can look at common elements in the experience of these teachers trying to teach a new subject very much according to their own notions about what "awareness" is and why it is important. Using the computer has brought new challenges to these teachers and has probed the limits of their existing routines for multiple centres of class activity.

Their problems are different from teachers in those schools -- Albert, Cambridge, Crompton, Winston -- using computers as a teaching aid. In these cases, computers are being used as part of a subject teachers already teach. We discuss these cases in the next chaper. These teachers' efforts are directed towards integrating computer work into existing instructional patterns by trying to adapt those patterns to the demands of the hardware and software or by trying to arrange hardware and software to suit the way they teach. Using the computer has brought challenges to how and what of their subject ought to be taught.

In this chapter we consider the nature of computers as a subject as these teachers construed it, how they taught the subject, and why they felt it was important to teach it.

---

[1] All schools and teachers in this study are identified by pseudonyms.

Table 1 - Schools Doing Computer Awareness

School	Bathurst Public	Ellesmere Public	Wolsey Public	Marlborough Senior Public
No. of Students	655	330	175	630
No. of Teachers	35	17	12	33
Name of Teacher	Mr. Heiberg	Miss Somerset	Mrs. Hughes	Mr. Owen
Years Experience	8	18	18	18
Context	Half-day French Immersion	Classroom	Library	Classroom
Grades	6	3	K-5	8

Table 2 - Set-up for Computer Awareness

SCHOOL	ACTIVITIES	SOFTWARE	HARDWARE	SCHOOL SUPPORT
Bathurst Public	utilities programming word processing	Crossword Magic Bank St. Writer French verb and noun drill Print Shop	Apple IIe 2 single disk drives Apple Printer colour monitor green monitor	principal
Ellesmere Public	low res.graphics drill designs	Apple Soft BASIC MacPaint MacWrite	TI Computer Apple II+ Apple IIe MacIntosh 2 Apple printers single disk drive colour monitor green monitor	principal
Wolsey Public	low res.graphics drill word processing	Crossword Magic Sticky Bear Bank St. Writer	2 Apple IIe 1 double disk dr. 1 single disk dr. 2 green screens 2 colour screens 2 Apple printers	principal
Marlborough Senior Public	drill word processing	Algebra 1,2,3 Bank St. Writer Golf Classic	Apple IIe linked to central CPU single disk drive	half-time computer teacher computer lab

COMPUTERS AS A NEW SUBJECT

We begin by looking at teaching computers as a new subject. Why say it is a new subject? First, the four teachers we studied who are using the computer in this way see it as a new subject that they will soon be expected to teach, and they say that now is a good time to become involved. They would like to see it taught and would like to promote it. The subject is also new in the sense that there is no established Ministry of Education policy governing its place in the curriculum below Grade 9, nor are there formal Board of Education policies. However, there are informal ideas circulating among these teachers that influence how the new subject is defined. Computer courses, which some of these teachers teach and which some take, are available from a local university. Some of these teachers have offered in-school professional activities day instruction and some have been involved in such activities. Computer Place, the board computer centre, produces a newsletter that, at least indirectly, suggests what the new subject is like.

The subject is also new in the sense that it appears to require every classroom teacher to have a set of expensive machines in order to do a good job teaching it. Few, if any, have as many machines as they think they ought to have. These teachers feel that they are having to operate the new subject with insufficient equipment. This problem is not new, but it is difficult to substitute other activities for the computer: one book can be substituted for another, and study prints can be used instead of a film strip but either you have a computer or you do not.

The subject is new in another, complex way. Computers can be used to teach about programming, as car engines are used to teach about auto mechanics, but computers can also be used to teach with. They are a teaching aid of potentially wide application: that cannot be said about car engines. The many potential uses of the computer provide an ambiguous backdrop to the decision to treat the computer as a subject rather than as a teaching tool.

These "newness" aspects of the computer as a subject are very much in the minds of the teachers we talked to who are using computers in this way. One way of looking at what the teachers are doing is to see their practice as an effort to work out for themselves the problems posed by the newness of the computer. We shall say more about this process later. It is important to say here that, while the computer as a school subject is seen as new, how these teachers teach it is very much influenced by their ideas about which aspects of the computer should be given prominence in the classroom and by their ideas about their role in teaching the subject. As we shall see, in some cases students are expected to teach themselves.

Finally, lest the distinction between teaching "about" and "with" computers seem cast in stone, it can be argued that any work on the computer contributes to an "awareness" of it and any awareness of it contributes to a greater capacity to think and to increased knowledge about something, and hence to some "subject" matter. The teachers we talked to did allude to these ways of looking at their work, but only in passing, and with no great conviction about how persuasive these are as rationales for computer use. It would seem that, unless these notions are more fully developed, they remain rather vague ways of trying to bridge the gap between "about" and "with".

With these introductory comments, we can look more closely at what teachers are doing and why they are doing it. The teachers we are considering here teach either primary or junior classes except for one intermediate teacher. With the exception of one who is a librarian and has her computers in the library, all the teachers are using computers in their classrooms.

STATUS OF SUBJECT IN THE SCHOOL

The teachers said that their own knowledge of computers in education was not extensive and that there was very little material available to guide them in their planning. Getting to know software was something they said they would most like to do but there was simply not enough time to do it. Miss Somerset said she was concerned about issues of scope and sequence in teaching computers as a subject and Mr. Owen made it quite clear that he wanted to know much more about what the curriculum for computers should be before he felt he could teach the subject to his class as a whole. He wanted a guideline with very explicit steps that would allow him to monitor progress by giving him something to test. He wondered just what ought to form the outline of the subject in the middle school and saw the subject now as a distinct "add-on" to his existing activities. Mr. Heiburg thought the subject should be recognized on the report card and be given a grade: this would be one way to show that it was being taught, that he had to teach it.

All of these teachers thought that in-service education had a role to play in preparing teachers to teach computers as a subject. The main concern was with gaining access to suitable software, software that would help them run the awareness activities with the least amount of interruption and classroom dislocation.

Principals

All of these teachers' principals expressed concern about the educational value of the computer awareness activities and the extent to which student progress was being monitored. Their uncertainty here can be seen as a reflection of the uncertain status of computers as a subject in their school, the experimental nature of the methods used to teach the subject, and the lack of policy in the field as a whole. Given these facts, it is not surprising that the principals, not as immediately involved in the computer projects in their schools, might muse about the purposes to which these machines are put. None of the four teachers conducting awareness activities expressed similar doubts, but all were aware that they were pursuing these activities against a backdrop of uncertainty about the uses of computers in education. All mentioned ways in which their work might link up with existing school subjects and with computers as a teaching aid, but none made the links a central part of the way they talked about what they did.

HOW TEACHERS ARE USING THE COMPUTER

Awareness

It is worth considering how computers are typically used for teaching "about" computers. One or two computers are set up in the room usually with two screens (high resolution green and low resolution colour), a disk drive, and a printer, but there are variations. One computer may be in the hall; a printer may not be attached; only one screen may be available; two disk drives may be available. Sometimes the computer stays in the room; sometimes it is moved about. If there are two computers, they are often not of the same type.

The teachers described their work as "computer awareness". Built into the way teachers talk about awareness are theories about scope and sequence in the new subject. Certain activities precede other activities, and certain activities are to be included at the elementary or intermediate grades while others must wait for high school. Miss Somerset, for example, had her Grade 4 children use the computer to create pictures of things they first designed using graph paper. We watched a student program her picture of a dog using Applesoft Basic. Miss Somerset talked about the appropriateness of such activities for junior children. Her approach to this was trial and error: see what was needed to help them get the idea and then see what happened when they went to the computer. Through her "experiments" she had found out more about the order in which she should present the information about programming, and about what programming routines she could safely include so that most of the children could get the idea and still create the picture.

Access to the computer in Miss Somerset's classroom was determined by a rota, which is a familiar device for ensuring equal access. Like the other teachers, she tried to ensure that as many students as possible had computer awareness experience. Behind this idea lies a theory about how children become aware of computers -- by being exposed to them. We might call this an "inoculation" theory: the more exposure to the machine, the more awareness will result. Awareness is developed through "hands-on" experience, not through just being told about computers. "Hands-on" experience is seen as a way to increase students' "comfort level" at the computer, a way to remove any fear they might have of the machine. There are some similarities here to the way the use of science laboratories is typically justified by science teachers.

Commonly attached to the awareness idea is a theory about problem solving. Computer awareness leads not only to how to operate the machine but to an enhanced capacity to "problem solve". The software is seen as providing opportunity for learning to manipulate the machine and for increasing the capacity to solve problems. In this way, virtually any software can be used, whatever original purpose its designers may have had, including utilities designed for teacher use and word processing programs. The notion of "comfort level" also determines a similar use of software: a wide variety of software can be used, whatever its original purpose, as long as it is relatively "friendly".

Programming, either using BASIC or LOGO, is seen as one type of awareness activity, as is the use of any software. Becoming "familiar" with types of software is part of the informal awareness curriculum. This includes learning how to evaluate and run software. Learning how to use peripherals is also part of awareness. Thus, experience with joysticks, koala pads, modems, and other peripherals is considered to be part of the curriculum. Parts of the computer and the names of the various peripheral devices are items in the list of topics to be covered in the curriculum in the same way that various operating commands in BASIC are taught.

The four case studies themselves, of course, yield many more details about how computers are being used as a subject. Perhaps the above might suffice as a brief overview of what teachers are doing. How do they manage to teach computers as a subject at the same time as teaching their other subjects?

THE "TEACH-YOURSELF" APPROACH

In all cases, teachers are doing at least two things at once at least some of the time. One computer, at best two, creates severe access problems for teaching the subject if access to the computer is thought to be the main way the subject should be taught. These teachers think that being at the computer is the way awareness is to be achieved and they have had to organize their classrooms accordingly. Students have access to the computer during class time and/or during recess, lunch, or after school. They have access according to a rota, or through petition or both. There are a variety of patterns used but they are all directed at getting as many students as possible on the machine, consistent with availability of the machine and the teacher's capacity to cope with the problem of doing two things at once or being available for computer activity support outside of class time when, typically, other school-related tasks also make a claim on the teacher's time.

Doing two things at once is not new for teachers. Teachers have well developed strategies for doing two or more things at the same time and there are many occasions when these strategies are used. Think of reading and math groups, of various kinds of self-selected project work at stations, and so on. Teachers are accustomed to monitoring these situations, satisfying themselves that productive work is being done, and interpreting students' behaviour in terms of the need for intervention. They have been able to resolve various kinds of episodes associated with multiple activities in the classroom.

One strategy is to ensure that the materials that students work with are sufficiently self-explanatory so that students are independent of the teacher. The teacher has to ensure that there is enough direction given so that the materials really do function independently. There are quite complex judgements to be made here calling for considerable experience. With experience the teacher becomes habitually capable of making such judgements by quickly isolating relevant features of the materials and characteristics of the children, and deciding how to proceed.

Without exception, the four teachers have used "teach-yourself" strategies to incorporate the computer subject into their daily routines (see table 3). The ways they have done this are interesting and can be seen in detail in the cases themselves; here we would like to comment on some general features of their strategies.

It is not surprising that the "teach-yourself" strategy is used because computers are teaching "machines" after all, and a teacher knows that drill and practice software is intended to at least rehearse children in things they need to know even if it does not explain or make plain what they are doing. Software often comes with documentation about how to use it that teachers have had to use to teach themselves, and it is a natural step to assume that children might be able to use these documents or, alternatively, use tutorials that might come with a program, as in the case of "Bank Street Writer".

There is a further, more compelling reason why teachers are interested in a "teach-yourself" approach. They view the children they teach as members of a computer-oriented generation, at least as able as the teachers at learning how to use the computer. At least some of the students are viewed this way by some of the teachers. These students are relied upon to help the teacher, other students, and even other teachers. This help involves trouble shooting and, more importantly, peer tutoring.

These computer "literate" students seem to know their way around the machine; they seem to be able to get things started and keep them going. Some of these students know more than their teacher about the machine. We met some of these students and we saw how they functioned in class. They would appear suddenly to help other students who were stuck; they would stay on and take over from students who had not quite got the procedures for programming graphics, for example; they wanted to talk to us about their interest in computers. They were attracted to the computer. There were perhaps five or so of these students in every class we visited.

There have always been students like these in class. They are enthusiasts who bring to school their special interests and share them there. What is unusual here is that some of these students are enthusiastic about a machine that is used to teach them and enthusiastic about what it can do. They have the time to explore the nature of this machine because they have one at home. It is not surprising that teachers who are teaching computers as a subject have the view that students can teach themselves. Some students are teaching themselves already.

Table 3 - The "Teach-Yourself" Computer Awareness Routine

TEACH-YOURSELF COMPUTER AWARENESS	DIFFICULTIES REPORTED
Subject goes on all the time	Machines scheduled elsewhere Students away/unprepared
Students learn through programming	Program errors undetected Students unsure of control procedures
Peers tutor each other	Students "debug" but do not tutor
Students share work in pairs	One student does most of the work
Students get help from documentation	Documentation too difficult to read
Access is a reward	Students bored with unsuitable software
Contact with teacher is minimal	Teacher needed to interpret syntax error messages, locate software

There is a further and perhaps equally important factor here: time. All of these teachers expressed concern about the time it took to prepare themselves to use the computer as another subject in the classroom. The main burden was previewing software. Given the time it takes to do this and the idea that students can teach themselves, it is not surprising to find teachers having students appraise software. Mr. Heiburg and Mrs. Hughes both have students assess software. In view of these teachers' interest in computers as a subject and in a "teach-yourself" approach to it, the nature of software preview becomes an interesting issue. If software is chosen primarily for "awareness" and primarily in terms of a "teach-yourself" approach, then certain kinds of software are going to be favoured: namely software that requires a minimum of teacher support and provides a maximum of student engagement.

LOGO has proved not to be a self-sustaining program in the eyes of two teachers. Mr. Heiburg said that the students had difficulty interpreting the feedback; he had let students tutor each other in order to overcome this difficulty. Mr. Mitchell said that the students found LOGO of interest at first but they grew bored with it once they learned to "get this little turtle whipping around the screen".

All of the teachers spoke about launching the students on their own through the use of supportive software. Their concern about software can be read in the light of the need for independent activity. Miss Somerset said that students did not read the instructions on the screen properly, and also that she wanted programs that manage instruction. Mr. Owen said that, although they liked math games, students got tired of the software he gave them and did not themselves initiate a search for something else. Mr. Heiburg found that some students had difficulty using utility programs he gave them because they did not know how to interpret "syntax error". He found that LOGO was not self-sustaining because students had difficulty using the manual to learn how to do it. Mrs. Hughes said she avoided software with complicated instructions.

STUDENT REACTIONS

Mr. Heiburg said that it was only because his class was keen and easy to control that he could operate a computer awareness program at the same time as he ran his French immersion program. With a more difficult class he would have used much more structured software, like drills, and used word processing and utilities less. Miss Somerset also spoke about effective control of the class. She found that students were excited by their computer work and that this was not easily handled. She had to keep in mind the abilities of her students to learn the programming routines. She continued to speculate about this but tried to be optimistic. Mr. Mitchell found it impossible to run a concurrent computer activity in his science lessons because his class was not sufficiently attentive. Mr. Owen found that, without a nucleus of computer literate students, it was difficult to operate an awareness program. On top of that he found that students were distracted by the presence of the computer and he had to reserve the computer for out-of-class time. Mrs. Hughes found that the children's capacity to read support documents affected her choice of software.

Miss Somerset found that it was difficult to use "Bank Street Writer" because students did not "read" what was on the screen. They would not follow the menu, perhaps because they did not understand what they were being asked to do: she thought that "Bank Street Writer" might be too difficult for them. Similarly, she said that some children did not actually do the computer graphics they had plotted out on graph paper, also perhaps because they did not understand what to do. Miss Somerset thought that the graphing activity might not be justified. Without guidance in this matter, she was exploring this area very much on her own. We saw students in Mr. Heiburg's class unable to use a utility program he had given them. He said that they "needed a more directed approach"; that is, they needed more instruction in the use of the utility before they could use it, but access to such instruction is at a premium. The teachers hope to operate the awareness program with a minimum of teacher input.

The nature of the software these teachers use affects their capacity to operate on a minimal input basis. Because of their interest in computer awareness, these teachers wanted their students to learn how to program. Learning how to program is one of the central ideas in the awareness concept. Programming took different forms: using utilities like word search that could be programmed; LOGO; low-resolution graphics; and BASIC itself. Using these programs, however, requires more teacher support than the more friendly drill and practice and tutorial programs. Word processing also requires teacher support, especially if students have difficulty understanding the relationship between commands and text management.

It is not surprising that the teachers relied on computer literate students to tutor other students and trouble shoot when needed. These students were available and they often knew just what to do. We found that children who came over to help other students in difficulty tended, however, to take over rather than to tutor their peers. We had thought that the computer whiz student would pose a problem for teachers: we did not find this to be so.

Computer literate students seem to be necessary for computers to be taught as a subject in the way these teachers are doing it. These students provide a model for the rest of the students, someone who can easily use the computer and show others how to do so. They can provide the teacher with a sense that something is being achieved that is associated with their awareness program. These students can program; they can produce interesting and relatively sophisticated products from the computer; they can share enthusiasm for computing with teachers who are, each in their own way, enthusiasts.

"TEACH YOURSELF" IN ACTION

Although the teachers try to make sure that children at work at the computer teach themselves, this does not always happen in practice. The programs the children use require teacher support. Without that support, students are bound to get off on the wrong track -- it is in the nature of programming and word processing. We saw two examples of this: one girl had entered graphics co-ordinates incorrectly. She had wasted about one hour doing this before the teacher discovered the problem. In the word processing case, the student did not know how to use the return key to paragraph, resulting in a print-out quite unlike what she had planned.

One approach to providing support is to give the class as a whole lessons on how to use the computer. Miss Somerset, for example, gave lessons on control keys to be used in graphics programming. Mr. Owen's students were given lessons on the computer by the school's computer resource person. Mr. Heiburg took his whole class through an introduction to the computer program by demonstrating it. Mrs. Hughes had all the classes come to the library where she gave them an introduction to the machine.

In spite of these efforts to prepare children to use the computer, the teachers still found themselves in the middle of two lessons, trying to do two things at once. It had become clear in our preliminary interviews that teachers were very much concerned about being able to cope with doing two things at once; this was true even of Mrs. Hughes who works in a library.

Mr. Heiburg said, "Your attention is bisected, trisected, and the class has to work with a certain level of freedom." Miss Somerset found the noise of the printer distracting, and she found that when she left the class to help the computer "class", students started talking. Mr. Owen found it distracting to have students working on the machine, and found that students rushed their work so that they could get access to the computer. He found it easier to work with smaller groups in situations where he could concentrate entirely on the computer.

PROBING THE TEACHERS' APPROACH

We talked to the teachers about the apparent difficulties they were having in running the "teach-yourself" approach. We were concerned to understand why they persisted with the approach in spite of the difficulties. In order to do this we presented the teachers with a set of elements that we felt characterized the situation in which they found themselves. We asked them to group these situations and explain to us the basis of the groupings. (Our procedures are described in appendix B.) From our analysis of their comments about these situations we gained an insight into the ways these teachers thought about the demands of teaching a separate computer subject.

The teachers tended to look at situations in terms of whether they had to intervene or could let the situation resolve itself; whether delays or interruptions were due to complex student characteristics or relatively straightforward mechanical problems; whether delays and interruptions could be quickly resolved or would require an extra effort; whether existing rules applied or new ones were required; whether routine responses applied or judgements had to be made.

Teachers seemed concerned about how much time it would take to unravel and resolve a delay or interruption episode. We had expected that worries about machine problems would dominate how teachers construed delays or interruptions but we found that they were more concerned about having to face complex student reactions to situations, like impatient and bored students or students getting wrong answers or disagreeing with answers; students whose actions were saying something complex about their response to activities planned for them and requiring the teacher to clarify the actions.

These are not concerns that arise solely with using the computer. They are fundamental, but the computer can add an extra dimension to the ambiguity of an episode because it is not clear just what is "bothering" students who, for some reason or other, do not "get on with it". Of course, as time goes on, and once ambiguous situations can be treated as routine, teachers will find computers a less perplexing element in the situation.

Perhaps these points can best be illustrated with reference to Miss Somerset's concerns about student collaboration. She felt that because computer work encouraged students to help each other, indeed even required them to collaborate to keep going, they might think that they could collaborate on tests or on their seatwork. Collaboration is an ambiguous activity in Miss Somerset's view. When, she asked, are students going too far by making too much noise and sharing work they should not be sharing?

Doing two things at once is made more difficult for these teachers because, unless the teacher has extensive experience of students' reactions to the software being used, time is required to resolve delays and interruptions. Teachers normally have this kind of familiarity with the self-directed activities they give their students, but this familiarity is built up over time. For example, certain types of self-instruction kits are often used by teachers and, over the years, they become familiar with how they "run". Getting to know how software runs is the same; it takes a long time and much experience. These teachers have not yet had this experience. It is interesting that Mrs. Thomas, a teacher who uses software for drill and practice, used a familiar kit, Language Master, as a touchstone with which to compare her experience with computer software. She compared the ways in which students react to the Language Master drills with the way they react to software.

We could see from our analysis of the teachers' comments about managing the computer that they are using an approach to computer as a subject that minimizes the demands on them. Nonetheless, as it turned out, many demands had been made that did cause problems, yet when asked what the benefits of persisting with the approach were, teachers said that they derived much satisfaction from the students' enjoyment of the computer activity, in spite of the difficulties. We shall discuss the nature of their satisfaction at greater length in the next section and in chapter 4.

WHY COMPUTERS AS A SUBJECT?

We asked the teachers to tell us why they thought computers should be a subject. They said that studying computers, like driver education, is intended to give students something they can use in the future in a tangible way -- to get a job, to be able to use computers in private life. Miss Somerset saw them this way, as did Mr. Owen who thought that students would need to know about programming. Mrs. Hughes wants her students not to fear computers, to be able to use them to make their lives easier. Like Mr. Heiburg, who feels that working on the computer provides students with a way of organizing their thoughts more accurately, they all stressed thinking skills. Mrs. Hughes talked of thinking skills achieved through experience with low-resolution graphics, although she said she had no way of telling whether or not such skills are actually improved through experience with computers.

Beyond the vocational and cognitive justification for including computer literacy in the curriculum (which we did not find highly elaborated), there were reasons more to do with making the classroom a more interesting and enjoyable place. Miss Somerset said that "it was a thrill for the students when they found they could do something different, something new, something creative". Mr. Owen remembered working on his computer course assignments with some of the students and sharing with them a common task. They were interested in what he was doing and were able to show him what to do. Mrs. Hughes said that her students enjoyed their computer experiences and "the kind of pleasure they get out of it gives me pleasure".

What the computer has to offer is open to many interpretations. These teachers are hopeful that there will be important benefits for their students in the long run. In the short run, they seem to be saying that computers add a new dimension to their teaching, something their students can look forward to.

WHERE NEXT?

When we asked the teachers what more they wanted for teaching their subject, they wanted, above all, time to prepare themselves. They also wanted more guidance; in fact they wanted a guideline that would outline the scope and sequence of the subject, although they were aware of the many unanswered questions about what was appropriate at their grade level. They saw their projects as contributing to an understanding of what the computer subject should look like in the elementary school.

These teachers all want to have a computer in their classroom; they want it to be part of the "furniture", as Mr. Heiburg said. They differed about who they, as teachers, were in relation to it, although all were uncertain about this question. Mr. Heiburg wanted his school to have a computer resource person but did not want that to mean that he would not have a computer in his room. Mr. Owen, whose school did have a computer resource person, wanted his students to be trained by that person so that they could use the computer in his room with minimum input from him. Miss Somerset also saw the computer as part of the furniture and she wanted to retain the role of expert computer teacher. Mrs. Hughes saw her work with computers as part of her work as a remedial/enrichment teacher and as a librarian. She has continued her remedial/enrichment role largely in terms of offering computer awareness to students who come to her. She operates as a computer subject teacher but within the broader remedial/enrichment designation. She saw herself as a computer resource person, informing other teachers about available software. In effect, she has taken on tasks that one would associate with a computer resource teacher. Her activities are very much like those of Mr. Mitchell at Marlborough School who is half-time computer resource and half-time science teacher.

The teaching of computers as a subject raises issues to which we have already alluded. At present, these teachers do not have a guideline to follow, that is, no curriculum for the subject exists. Put this way, what does not exist is a rationale for including computers as a subject in the elementary school. Justifying computers in the elementary school raises questions about the whole curriculum. Where do computers fit in? There are, of course, various arguments to be made for computers but these are usually made without considering the whole curriculum. These teachers make it quite clear that they are "doing computers" as an additional subject, fitting it somehow into an already full program of activities. How will time be made available to include work on computers? There are critics of the elementary school who say that science is not given enough time; how will time be found for computers as a subject? We shall return to these questions later when we consider the curriculum implications of computers as a subject.

CHAPTER 2: USING MICROCOMPUTERS AS A TEACHING AID

HOW IS THE COMPUTER INTEGRATED INTO THE SUBJECT?

Four schools -- Cambridge, Albert, Crompton, and Winston -- are using computers as a teaching aid in a variety of ways, ranging from drill and practice to simulations. Although there are significant differences between these uses, they have in common the use of the computer as a teaching aid (see tables 4 and 5).

The term teaching aid needs some defining. Teachers have always used a variety of aids to help them carry out their tasks; these aids can be used by the teacher or by students directly but, however used, they are meant to enhance the teacher's capacity to help students understand the subject matter they are studying. To understand the use of the aid, it is essential to understand how it fits into the plan of the teacher to teach particular topics in particular ways; subject matter and methods of teaching are at issue when we consider the use of a teaching aid.

In this chapter we will look closely at how the teachers used the computer as an aid to teaching, paying particular attention to how they may have modified the topics they teach in order to make use of the computer. We will consider what these teachers hoped to accomplish through their use of the computer, and the factors that influenced the way they used it. We will try to make sense of the various uses of the computer in terms of the teachers' purposes. Before considering these cases as a whole, we will review the outlines of each case.

Table 4 - Schools Using the Computer as a Teaching Aid

School	Albert Secondary	Crompton Public	Winston Elementary	Cambridge Middle School
No. of Students	1586	500	230	733
No. of Teachers	84	25	13	37
Teacher	Mr. Devon Mrs. Melville	Mrs. Eliot	Mrs. Thomas	Mrs. Everett
Years Experience	22 7	14	10	11
Subject or Teaching Area	Geography	Core Conversational French	Reading Spelling	Compostion
Grades Taught	9-13	4-6	1-2	7-8

Table 5 - Instructional Uses of Computers

SCHOOL	ACTIVITIES	SOFTWARE	HARDWARE	SCHOOL SUPPORT
Albert Secondary	tutorials simulation	Buflo Oil Search, Mill Stratigraphy Weather systems and forecasting	6 Apple II+ and IIe 6 green monitors 2 colour monitors 6 disk drives 2 printers plotter	principal head of geography
Crompton Public	drill and practice	Magic Window Hangman Crossword Magic drill programs	Apple II+ single disk drive green monitor colour monitor	vice-principal/ computer co-ordinator
Winston Elementary	drill practice word processing	Magic Spells The Learning Line Tic Tac Show	Apple IIe Apple IIc green monitor	principal
Cambridge Middle School	word processing	Bank St. Writer	Apple IIe 2 disk drives green monitor colour monitor	half-time computer teacher computer lab

The Cases

Mrs. Eliot and Mrs. Thomas use computers to give children practice in essential routines in French and mathematics respectively. Mrs. Eliot has divided her class into groups of students who rotate through different activities including computer work. She selects the software that will be used so that it is related to what is going on in her French program. At other times she uses a rota to control access to the computer; some students work on the computer while Mrs. Eliot teaches the rest of the class. She uses a mixture of small group activity incorporating computers and whole class teaching with parallel computer activity. Her group work method enables her to incorporate computer activity, but she has found it a challenge to run these multiple activity classes because she has had to learn how to divide her time among the groups and to prepare the students to work on the computer.

Mrs. Eliot uses peer tutors to support computer activity by showing a few students how to operate the software so they are available to help other students. These peer tutors are particularly important when she is running the computer work parallel to teaching the rest of the class because she finds it difficult to be available at a moment's notice when students have difficulty with the computer. She finds the change-over at the computers disruptive when the computer is used at the same time as she is teaching the rest of the class.

She thinks that, in the long run, she will be able to individualize her approach to teaching French, once she can get hold of suitable software. In the short term, she hopes her use of computers will stimulate interest in French.

Mrs. Thomas uses her computer for drill and practice in a special education class, mainly with Grade 1 and 2 students. She is hopeful that computer experience will enhance the development of basic skills. Although she has not found that using the computer makes a significant difference in developing basic skills, she does find that students enjoy doing their skills work using the computer. She has found that the computer can give endless practice in a way she cannot, and, like other teachers, she wants to be able to set children to work on the computers and have them work on their own. In practice, things do not always work out this way since, for example, some children have difficulty reading what is on the screen. For some activities, like LOGO, she relies on students teaching themselves.

Mrs. Everett teaches language arts to Grade 7 and 8 classes. She uses the computer for word processing as part of an experiment she is conducting on writing. In order to see what effect composing at the computer might have on certain elements of the writing process, work on the computer is integrated with the work the class is doing, although students using the computer may be writing their stories while the rest of the class is doing other work or being taught by the teacher. All members of the class are required to produce drafts, discuss these with peers and with the teacher, and submit final drafts to the teacher for grading. A group of ten students, who are part of the experiment, spend about twice as much time as the rest of the class at the computer and are more familiar with "Bank Street Writer" than the other students.

Mrs. Everett has found that the students enjoy seeing their work "printed", and she hopes that their computer experience will make them feel good about their writing. She has learned more about how students revise their work as a result of her experiment with word processing.

At Albert Secondary School both Mr. Devon and Mrs. Melville use tutorials and simulations as part of the geography classes they teach. Mr. Devon's use of the computer is an extension of his interest in simulations in geography. He has found that the computer improves the quality of the simulations, and that tutorials are helpful in teaching certain difficult geographical concepts like weather fronts and in helping senior students process, display, and analyse geographical data. Students generally work on six machines in a computer lab adjacent to the geography classroom. In Mrs. Melville's simulation lesson two computers were wheeled into her room and students worked in groups and took turns at the computer.

Both Mr. Devon and Mrs. Melville stressed the need for appropriate seatwork to accompany computer use. Mr. Devon had written seatwork materials himself to support the software and, without this, he said, he could not use the computers. Both teachers spoke about getting used to teaching through multi-group activity and how this was different from whole class teaching in terms of the amount of material it was possible to cover, the classroom climate, and demands on the teacher. They both relied on student "experts" to help them manage computer activity.

Mr. Devon said he encourages students to talk to each other at the computer and he enjoys being able to make one-on-one contact with them in the multi-activity setting. Student enthusiasm for computer-based work encourages both Mr. Devon and Mrs. Melville. Mrs. Melville liked the idea that students had to make decisions for themselves in the simulation because these decisions can become the basis for discussion.

THE EXPERIENCE OF INTEGRATING COMPUTERS

With this brief review of the cases where computers are being used as a teaching aid we can move to discuss three common elements in teachers' experience with computers: methods of teaching the subject; goals for teaching the subject; relationships with students.

Methods

How these teachers teach has been influenced by the computer. Mrs. Everett has found that she can cope with students doing work parallel to the rest of the class, and that students can be relied upon to solve their own problems and be sensitive to what she is doing with the rest of the class. Mrs. Thomas has taken a closer look at the different ways she provides remediation; she has probed the potentials of what she usually does by contrasting them with computer-based instruction and vice versa. Mrs. Eliot has explored the use of multiple activity groups in French teaching as a way of incorporating the computer into her lessons, and this has given her experience in this teaching approach. Mr. Devon has developed material to support the multiple activities that go with computer work, and has increased his capacity to engage students in "what if" activities. Mrs. Melville has used group activities with general level students and has experimented with open-ended lessons.

As in the cases of the teachers teaching computers as a subject, there are dilemmas involved in integrating computers. We saw in chapter 1 that, although the teachers hoped to operate a parallel computers-as-subject course in their classrooms, this was not possible because teachers found themselves doing two things at once and having to cope with dilemmas associated with the ambiguous status of what they were trying to teach and with the limited access to machines.

To work on the computer, students need access during times when the rest of the class is doing other things and at lunch hour and after school. Teachers are caught between giving regular instruction and supporting the parallel computer work. These teachers also rely on students to act as peer tutors and on students teaching themselves how to operate the software. While these arrangements work most of the time, they do not work all of the time, and teachers have to make choices between helping students at the computer or continuing with whole class teaching.

It is apparent from the cases that the teachers have invested considerable energy in preparing themselves to use the computer as an aid. They have taken courses, attended workshops, reviewed software, analysed students' work, trained students to help them. They have invested time, especially in locating and familiarizing themselves with software. It has taken time to find software that really supports what they want to do, or to get it to run properly, and to find ways to show students how to use it. Some teachers complained about software availability, relevance, documentation, and technical quality. Time commitment and availability of good software raise questions about the actual benefits of computer-based teaching that need to be addressed, given that teacher time is limited and usually satisfactory alternatives exist for many computer-based learning activities.

PROBING TEACHER VIEWS

The teachers spoke about the difficulties of integrating the use of computers into classroom routines, particularly the problem of supporting students at the computer. We were interested to learn more about how these teachers approached management episodes associated with the use of computers. To probe their views, we used the clinical interview based on a sorting task involving computer-related management episodes (see appendix B for a description of the method). We found concerns about coping with the ambiguity in situations that involved some delay or interruption, as well as concern about how much the teachers had to do in order to deal with situations that arose when computers were being used. Pervading their concerns was a high level of interest in time, in being able to resolve episodes of delay and interruption quickly, and in avoiding wasting time in class.

The teachers spoke about their role in terms of giving guidance or maintaining discipline; being able to control things at a distance or through one-to-one encounters; needing to give high or low attention to students; having to deal with students or equipment. They contrasted instructional episodes with management ones, and situations for which ground rules existed with ones where they did not.

We found that teachers did not automatically assume that either student or software was at fault when delay and interruption episodes occurred. They tended to want to know more about these situations. However, there was a tendency to think that if students were having difficulty with software then they might not have read the instructions properly. The teachers' views helped us to understand what they meant when describing their experiences in adapting to the demand of the computer as an integral part of their teaching. We could see how the computer-based activities made episodes of delay and interruption more ambiguous, how levels of teacher support for individual students had been affected, and how the way teachers budgeted time was affected. We will deal with these issues in greater detail in the last chapter.

Goals

The teachers have had to re-examine the purposes that govern their subject teaching. The advent of the computer has raised issues about what is important in the subjects they teach. The experiments these teachers are conducting are concerned with what should be stressed and what might be left out in the process of incorporating computer-based instruction.

Mr. Devon, for example, has reappraised the way he teaches geography. Moving into computer-based teaching has been a way for him to renew his approach to geography, he said, by stressing analysis and judgement rather than sheer volume of subject matter covered. He has had to accept that some topics he once taught can be taught no longer. The positive reaction of the students has been a significant factor in making the extra effort required to use computers worthwhile. Mrs. Melville has found that the simulations she has used stimulate greater thought but less than she had hoped. Both feel that their use of the computer has allowed them to use material involving judgement and discussion, and to retain student interest and enthusiasm. Mrs. Eliot has found that using computers has added a "new dimension" to her teaching; one that is more concerned with assimilation through using and enjoying language rather than just "learning" it. Mrs. Thomas has found that, because computers can provide endless practice, she is able to work longer with each of the children she teaches. The computer also helps her keep the children's interest in what they are doing. Mrs. Everett has begun to analyse her ideas about effective composition as a result of trying to promote its improvement through word processing.

In the short run it is perhaps not surprising that teachers view their experiences in a positive way. First, no one wants to say that things did not go well; there is always that element in the presentation of self. Aside from that, students have responded to their teachers' efforts apparently in a very positive way and, in spite of some difficulties, the teachers have found rewarding the various new "elements" in their teaching.

All of these teachers are assessing for themselves the potentials of computer-based teaching in their own subject area. They have found that student response has been favourable and they have been able to accommodate the extra demands made upon them by the experimental approaches they are trying. But what has been the effect on their capacity to improve instruction? In one sense, the very process of experimentation has led to existing practices being questioned. That is a positive outcome of the process and will be considered later when teacher education issues are discussed.

There remain, however, some questions about these various approaches that ought to be explored further in the larger context of how computers can make an effective contribution to instruction.

In the case of drill and practice in remediation or special education, software designed for a wide variety of student uses is being used with children with specific learning difficulties. How effective is this software? Assuming that these difficulties are well diagnosed, ought the remediation to be more refined than broad spectrum software? Is it enough that these students enjoy this software?

In the case of software used for drill and practice in French, how do these programs contribute to the goals of core French teaching? If it is true that little suitable software is available, is there much point in radically altering teaching methods to accommodate the computer? There is the further question about what is suitable software for core French. Given that the students have difficulty reading French instructions and must have them in English, how valuable is computer-based core French teaching at all?

In both of these cases, it is assumed that drill and practice software is an effective way of learning vocabulary. What assumptions are built into that idea? How often must a student have access to a computer to derive benefit from it? Is drill and practice this way more effective, all things considered, than more traditional ways of teaching?

Positive student responses are important, but there are a number of questions that need to be asked if computer-based teaching is going to meet the potential many claim it has. In order for it to meet that potential, there are curriculum and teacher education issues that emerge from the experiences of these teachers that have to be addressed and that we will consider in chapter 4.

Relationship with Students

Mrs. Eliot has used peer tutoring -- a new way, for her, of relating to students. Mrs. Everett has also relied on students to help each other and has found that they have learned much from each other. She has found out more about individual approaches to writing as a result of her experiment with word processing. Mr. Devon has also used peer tutors and has made himself available to students across non-instructional times so that they might have access to computers. Mrs. Melville has found that she is called upon to be a support person, to help students pursue tasks set for them by the computer. Mrs. Thomas has made herself available to other students in her school so that they can use the computer, and has found that some of these students have been able to show her something of their ability to use the computer. In every case the teachers spoke about the enthusiasm of their students as a positive element.

Although student response is positive, and teachers have been able to rely on supportive peer interaction, there are questions about how best to learn from computer experience. Consider the many difficulties attached to promoting and maintaining effective class discussion of open-ended questions, especially with less academically oriented students. If the open-ended elements of simulations, for example, are not stressed or examined, is there not a danger that the simulation will not lead to a level of class activity beyond learning the essential concepts involved? Access to simulation material alone is not enough. There are also questions about methods of whole class teaching and the way the teacher can function to initiate and sustain discussion in that setting; for example, we did not see any whole class teaching using the computer. Is a valuable way of using computers being ignored? Is this because of technical problems or does it have to do with a teacher's capacity to integrate computer activity into whole class teaching methods?

Word processing is thought to be a good way of teaching composition, but what are the elements of good composition to which word processing contributes? There seems to be some uncertainty about this. Given the fact that Mrs. Everett's students are not good typists, and that it takes time to learn word processing, are the benefits, if any, worth the extra effort and investment needed to provide reasonable access? These are questions that need to be looked at by teachers as they critically assess their practice.

These questions are not meant to detract in any way from the experimental efforts of the teachers involved. Indeed, these experimental efforts are beginning to shed light on what the issues are; they are helping to refine the questions that need to be asked and are very valuable as a source of insight into the nature of the practice. Our point is that these questions need to be dealt with in the context of curriculum and teacher education.

All of the cases raise issues about how to study these questions. Is it reasonable to expect that teachers occupied full time and with no other support can undertake the kind of complex research activity that would be required to pursue these matters? On the other hand, is it possible to pursue this research without a significant, co-operating role for the teacher? It would seem as if these teachers would need more than access to a computer to fully participate in such research. Time and training, as well as defined relationships with outside researchers who could complement the work of the teacher, would be elements in this process.

Such co-operative activity might become a form of in-service education and will be discussed later in chapter 4.

Some of these questions do not require empirical work at all. The place of microcomputers as a subject in the curriculum is not an empirical question but a philosophical one, subject to the methods of philosophical analysis. The value of open-ended discussion, were it to be achieved, is not an empirical question either, although how to enhance it is. Such a question raises the problem of deciding which effects of using computers in instruction are to be most prized in assessing the value of computers. These cases point to a number of possible effects that might be valued; how are these effects to be assessed? A further question concerns the role of the teacher in helping to solve these philosophical questions. We shall return to these issues in chapter 4. In the next chapter we look more closely at the practice of all of the teachers in order to see what matters of general significance emerge from their experiences with microcomputers, either as a tool for instruction or as part of a new subject.

CHAPTER 3: INTERPRETING THE CASES: THE CHALLENGE TO PRACTICE

LEARNING FROM "GRASSROOTS" INNOVATION

The Context

The teachers in these case studies are exploring microcomputer-related issues chosen by them as interesting. By and large, they have tried to see how computers affect either methods of instruction or learning outcomes. Whatever the outcome of the formally declared pilot project objectives, these projects have given the teachers a chance to experiment informally with new approaches to teaching; to innovate in ways they considered relevant. The key to being able to do this is the access teachers have been given to a relatively scarce resource: a complete computer set-up. Moreover, they have been given access to expensive software, and have been supported in various ways by their school administration and resource people in pursuit of their own interests. This is indeed a "grassroots" approach to innovation.

These teachers are not required to "implement" anything other than what they choose to do. It is they who have decided what they will do and what resources they need to do it. None have everything they want. Each has a wish list, but they all have the essential equipment to pursue their teaching ideas and their fascination with this new technology. They have all "volunteered" to become involved in what has proven to be a time-consuming and at times frustrating process. Undoubtedly there are many factors that might explain why these teachers got involved in the first place. None would be unfamiliar: renewal, career, personal interests, curiosity, and so on. These reasons do not concern us here.

What does concern us are the lessons that can be learned from interpreting these cases. Clearly, there can only be tentative conclusions but we hope that they are ones worth testing further. In this chapter we will look at all of the cases taken together as examples of "grassroots" innovation that was intended to provide teachers with initial opportunities to test practice. We will look at the experiences of these teachers in terms of the pitfalls and opportunities presented to them through their participation in this innovation. In the final chapter we will look at the implications for curriculum and teacher education that might be taken from these cases.

The positive side of "grassroots" innovation is that one can pose problems relevant to one's situation. All of these teachers chose to explore elements of computer activity that interested them. They had images of how the computer might function in their classroom and they were prepared to make them concrete. Although all expressed satisfaction with what they had accomplished, they also spoke about not being able to carry out some of the things they had planned, and they felt that having to document their practice in the way that the board had asked them to was burdensome. On the other hand, they were left alone to get on with their projects with minimal interference. Some felt that they needed more support from the board but not necessarily in the form of directions about what to do (see Ontario Ministry of Education 1983; Lartner 1983).

These teachers discovered that there were aspects of what they had wanted to do that could not be done; the software did not exist, or there were not enough machines, or their own expertise was insufficient (see table 6). By discovering these things, they were able to adjust their activities to what they could manage and test their ideas within a realistic framework. As Miss Somerset said, how else can ideas be tested except in the realistic context of the school?

This process could be improved, of course. Teachers could consult with others outside the school about how to conduct in-school inquiries; more time could be made available to them; different notions about how to organize and conduct in-school research other than the traditional quasi-experimental method could be considered. There seems to be considerable scope for improving on the "grassroots" approach adopted by the board, which has already yielded interesting results. A missing element in the "grassroots" approach was curricular guidance. What should a computer curriculum look like in the elementary school? We will discuss that issue in the next chapter.

Reflecting on Practice

In talking to these teachers it became clear that they had used their experiences of innovative activity to begin to reflect critically on their practice, to ask questions both about what they normally do and what they were trying to do that was new. After all, they had chosen to alter aspects of their practice, and they had a vested interest in carefully considering what their experience meant for that practice. There are ample examples in these cases to illustrate this outcome of "grassroots" innovation.

Table 6 - Software/Hardware Problems Reported

PROBLEM	FREQUENCY OF MENTION	% OF MENTION
Inappropriate software	7	16
Computer noise/distraction	5	11
Preview time-consuming	4	9
Too few computers	4	9
Modem/joystick/monitor	4	9
Not enough software	3	7
Storing computers	3	7
Locating computers in classroom	3	7
Variety of machines confusing	2	4
Disks not durable	2	4
Access to computer-managed learning software difficult	2	4
Voice on synthesizer	2	4
System down	1	2
Getting copies of disks/ replacing damaged disks	1	2
Getting access to computer	1	2

We do think, however, that this process could become more powerful. We found that teachers did not push their critical scrutiny of practice as far as they might have in pursuing the lessons of their experience (see also Hartley and Bostrom 1982). This process depends on the framework one brings to the analysis of practice. It is unrealistic to expect teachers to be able to step back easily from practice; yet, if this could be done, the benefits of "grassroots" innovation could be substantially increased. Some way of institutionalizing this process is needed and more will be said about this in the next chapter when we discuss teacher education.

Idealization of practice is a constant danger with self-education. The teacher has a vested interest in having things come out well and the temptation to think wishfully about practice is strong. In a job with so many uncertainties, it would be surprising if teachers did not engage in such thinking. We suspect that the constant association of computer activity with the development of "problem-solving" skill is a form of wishful thinking, but we also think that researchers like us who ask too many questions are going to be managed by our respondents with references to things like problem solving. Thus it is a moot point whether teachers really believe that these students are developing "problem-solving" capacity. More likely, they do not know in detail what the cognitive effects of instruction are and do not worry about them as much as other, more highly prized effects (see also Sheingold 1981). In fact, a number of the teachers were quite frank, confessing that they did not know what the cognitive outcomes of children's computer experiences were.

Although the cognitive outcomes of teaching are a complex issue, we worry that teachers may be too easily satisfied by limited positive benefits, and perhaps too quickly discount negative effects. Given the effort they have invested in computers, there are lessons to be learned from their experience that would repay teachers' attempts to discover them. Such attempts might form part of an in-service education agenda; for example, those who favour computers as a subject may be overestimating their cultural and social significance and underestimating problems of the whole curriculum at the elementary level, or again they may not -- curriculum issues abound here. These points need to be studied.

Those who favour computers as a teaching aid are faced with questions about the usefulness of the computer in comparison with other ways of achieving the same objectives. It is wishful to think that computers by themselves can create improved instructional contexts. Given pedagogical reform that many think is needed to increase the intellectual productivity of school experience (Judd 1983, for example), it is hard to see how computers can be placed at the centre of school renewal. One can imagine how computers might contribute to inquiry, for example, but only in the context of ideas about how schools can foster inquiry, what inquiry is, and what teachers need to know to be able to stimulate it. Nonetheless, many think that computers can help in the process of developing an inquiry orientation to teaching (see Simpson 1984; Bostrom 1982; and Hartley and Bostrom 1982).

The point is that there are some quite difficult decisions to be made here that have very complex and far-reaching consequences that go well beyond simply placing computers in schools.

How can these issues be resolved if one thinks only wishfully about the learning and vocational benefits that are supposed to come from computer experience? The need for a well developed curricular rationale is obvious here -- something against which teachers could test their own ideas.

If computers are thought to contribute to increased "problem-solving" capacity, then some sense of what problem-solving capacity is will need to be outlined in school-relevant terms, as will some theory about the relationship between problem solving and, for example, programming. As it stands, it is hard to see the connection. This is a task for curriculum development activity.

What the "grassroots" approach can contribute is a school context in which these issues can be debated. In the process of curriculum formation, teachers can study what actually goes on as children use various kinds of software. Take, for example, the reports on LOGO in these cases. This is LOGO "in the raw": teachers trying to find a relevant context for LOGO and not being very successful at it. This is not a matter of assigning blame but of learning from experience: what can LOGO offer teachers? How can its benefits be realized in school-relevant terms? Some might want to argue that schools are not ready for LOGO; others may say that LOGO is not ready for schools. The point is that these "grassroots" efforts to use LOGO, and we mention LOGO only by way of example, suggest what sorts of issues need to be discussed when planning in-service activities associated with powerful software. We will return to this issue in the next chapter. We now move on to look at the challenges to practice posed by using computers in the classroom.

CHALLENGES TO PRACTICE

The Routine and the Novel

"Grassroots" experiences with innovation teach us something about how teachers cope with innovation. Doing things in new ways is an extremely complex process, which we have not been able to describe very well and for which we lack adequate metaphors. One way of looking at the teachers' behaviour in relation to innovative ideas is to think of the teachers as responding to routine and novel elements: parts of the innovation fit easily into existing routines; other parts do not. Table 7 indicates the routine and novel elements of these teachers' experience as we have interpreted it.

Table 7 - Routine and Novel Elements in Using Computers

ROUTINE	NOVEL
Rota access to activity	Deciphering error messages
Peer tutoring	Students as experts in subject matter (programming)
Access to activity as a reward	Students demanding teacher support for ambiguous problems
Working in pairs	High level of individual student attention required
Work is guided by printed documents	Use of material only remotely connected to ongoing teaching
Teacher teaches without interruption	Student demand for access to medium of instruction
Students work on their own	Student control of activity
	Development of seatwork materials
	Students unwilling/unable to read printed documents

This is a radically oversimplified picture. First of all, there is no such "thing" as "the" innovation. New ideas, if they are at all interesting, are too complexly perceived to be considered one thing, yet certain common responses of the teachers can usefully be interpreted in terms of the routine and novel elements of innovation. For example, procedures required to launch and sustain drill and practice activity at the computer do not appear to strain existing routines too far, but having to support computer activity parallel to teaching the rest of the class does place strain on the teacher. LOGO is seen as requiring novel responses but is not seen as fitting in with familiar teaching routines. Teachers realize that LOGO is a much favoured form of studying computers as a subject but they have trouble seeing it in routine terms and, according to the cases reported here, have not had much success integrating it. Indeed, in three cases, efforts to create routines from it have led to the conclusion that having students learn BASIC is preferable to doing LOGO.

Bringing elements of innovation into familiar routines is an important issue. Teachers cannot be expected to suddenly abandon their practice in favour of teaching activities quite remote from what they are used to. The experience of innovation cannot be all novelty. There is simply too much at stake, and yet a totally routine approach to innovation is no innovation at all. There has to be enough that is novel to pose a challenge to practice.

For us, the process is not one of substituting one practice for another but of subjecting existing practices to a challenge posed by another well-conceived practice. The effect of the challenge is to provide reasons to modify the existing practice through a process of critical comparison. Of course, things do not always work out this way. For an alternative practice to be understood it needs to be properly experienced. In these cases, it did not look as if LOGO was experienced in a way that would enable it to act as an effective challenge; perhaps its challenge to practice never became clear or, if clear, was too novel. Its potential as a challenge appears to have been muted in these cases. By way of contrast, computer simulations at Albert Secondary School were an extension of pre-existing work on simulation. The computer simulations had many points of similarity with non-computer ones and were easily assimilated.

These "grassroots" efforts at innovation can be seen as exercises in finding ways to match existing procedures with innovation characteristics. Take teaching computers as a subject, for example. Rather than establishing a time when all students would study this subject (and thereby render the one machine useless), the teachers adopted a rota system. Access to the computer was incorporated into the rewards and punishment structure of the classroom. Teachers are used to doing more than one thing at once by setting the students work that "runs itself". They used this strategy with the computer as far as they could. Nonetheless, there were problems in using this routine with the computer. One of the novel aspects of teaching computers as a subject was the programming activity considered to be part of computer awareness. That, as it turned out, was not something the students could be left alone to do with minimum support. They required much more support than was expected, and this created problems for the "run itself" approach to the subject. A safer approach was to use CAI software for awareness purposes by thinking of familiarity with different types of software as a literacy topic.

Another novel aspect of using computers for instruction was the ambiguity of student problems at the computer. Were they due to machine, software, or student characteristics? The extra demand on teachers that resulted from having to sort out delay and interruption episodes was a novel aspect of using computers and one not easily handled by existing routines. A wide range of software could yield a wide range of problems: different machines had different operating characteristics for the same software, and the range of students' responses was unknown. Only considerable experience would allow teachers to integrate this aspect of using computers in instruction into their teaching routines. How teachers do this would be a useful item for teacher education.

THE INSTRUMENTAL AND THE EXPRESSIVE

Innovation requires extra effort of teachers. A question one is bound to ask is, what is the pay-off for teachers willing to engage in "grassroots" innovation? This is not a matter of a mercenary quid pro quo. Teachers are rational creatures given to the pursuit of their best interests like the rest of us. They want to put the best face on their practice. We can only estimate how they assess the value of their work, and hypothesize about the relative importance of different types of benefit from innovation.

A useful way of thinking about how teachers respond to innovation is to look at instrumental and expressive elements of their behaviour. Here we are using a distinction developed from the social psychology of Harre (1979), who divides effects of human behaviour into practical outcomes, which allow one to find shelter and sustenance and "those directed to ends such as the presentation of self as rational and worthy of respect, as belonging to a certain category of being which I shall call 'expressive aspects of activity'" (p.19). What Harre calls practical we call instrumental. Instrumental behaviour, in our case, is directed at producing student learning. Expressive behaviour is directed at creating respect for the teacher and liking for the subject, for example. This expressive behaviour can have an indirect effect on learning by creating an appropriate climate, and learning outcomes may come to influence how expressive behaviour is appraised. A given teaching behaviour can have both expressive and instrumental elements in varying degrees. Table 8 gives some examples of instrumental and expressive elements of teaching with computers.

The usefulness of this distinction lies in the fact that, without it, it is difficult to make sense of a variety of teacher decisions. Indeed, without it, teacher decisions can seem contradictory and confused. How is one to make sense of the idea that a teacher does not favour LOGO as a way of learning programming yet is quite happy for students to tutor each other in LOGO, or that a teacher wants to continue an experiment that she considers impossible to do?

Table 8 - Instrumental and Expressive Elements of Computer-Based Teaching

INSTRUMENTAL	EXPRESSIVE
Teaching basic commands	Students work on modern equipment: teacher is up-to-date
Promoting problem solving	Students to make their own rules: teacher is flexible
Producing better writers	Students have fun: teacher teaches an interesting subject
Rehearsing math facts	Access available out of school hours: teacher is dedicated
Teaching spelling	Students have one-to-one access to the computer: teacher meets individual needs
Tutoring students in basic concepts	Computer literate students have privileges: teacher is discriminating
	Teacher is familiar with and collects large quantities of software: teacher is highly competent

From an instrumental point of view, for reasons we have discussed, teaching the class how to program through LOGO is not favoured but, from an expressive point of view, allowing enthusiastic students to teach each other how to use LOGO is favoured. The teacher is giving enthusiastic students the opportunity to experience a challenge. In his own eyes, and hopefully in theirs, he is someone who appreciates the needs of some children for self-directed computer activity in spite of the fact that he does not consider LOGO useful. But instrumental issues are not at issue here. By allowing students to explore LOGO the teacher expresses his interest in computer literate students and displays his willingness to let them teach themselves. In this way he maintains certain important relationships with these children.

Other examples can be found in the cases of expressive behaviour taking precedence over instrumental. A teacher finds that students apparently do not improve their basic mathematical skills any better through computer activity than through more traditional means yet she wants to continue to investigate this issue. Is the point here to find a better way of teaching routine material or to provide varied experiences for students that enhance their attitude to learning to do routine work with the teacher? By having the computer in the classroom, the teacher is able to make a statement about the kind of experiences she is able to provide for her students, about her attitude toward them.

How is one to explain that two teachers feel that it would be better for their students if they were to learn about computers from a specialist teacher in a computer lab, yet insist that they should have a computer in their classroom for that very same purpose? From an instrumental point of view, this does not make much sense, but expressively it does. The decision to have a computer says something about the kind of experiences available in the classroom; about where the teacher is in relation to "modern" things like computers.

Do these expressive "statements" matter? We think that they do because they are part of the kind of social person a teacher is, part of the way teachers make statements about what matters to them and what sort of climate for learning they are trying to create. The way they view their accomplishments as teachers is in no small way related to these personal statements, and we think it is important for teachers to recognize what they mean. This analysis of the symbolic elements of teaching is part of coming to understand what an innovation means in practice. It is an analysis that teachers need to make about their own practice, and is a way of coming to know oneself better as a teacher and thus one of the benefits of becoming involved in innovation.

Innovations often involve new ways of assigning meaning to practice. Teaching something using the computer means something different in expressive terms from teaching the same material some other way. Teachers are aware of these meanings and their significance, and are engaged in a process of re-assigning meanings as they try new practices. Making these processes more explicit is a way of learning from the process of innovation and could be a valuable part of in-service education as teachers systematically analyse the pay-off they sought in teaching about computers.

Teacher Influence

It is customary to think of the teacher's work in terms of instrumental outcomes, usually student achievement. Thus, teaching is often linked directly with learning and defined in those terms. However, to understand the actions of the teachers, it is necessary to think that teachers are doing more than acting as instruments of student achievement.

The concept of teacher influence is useful here. In earlier work (Olson 1980, 1981, 1982), in order to understand teacher reactions to an inquiry-based science program, the idea was advanced that teachers influence lesson activities in complex ways that only indirectly affect learning. It was found that teachers were unwilling to abandon secure routines in the face of a curriculum that demanded many novel responses. Teachers valued these routines for their expressive power. Through specialized activities, teachers prepared students to write external examinations, partly by convincing them that the teacher was a reliable guide who "knew the ropes". These teachers expressed their "reliability" in many ways, and by looking at how they exerted their influence through the "lens" of the expressive concept, we could understand how the classroom "worked".

We think the expressive "lens" is valuable in the cases we have been looking at here. In the case of computers as a subject, teachers have isolated the computer activities, allowing them to proceed without affecting the on-going "official" work of the class. They have used access to the computer as a way of encouraging better behaviour and work during "official" time. At the same time, the teacher maintains a "modern" posture vis-à-vis certain computer oriented students, thus increasing his or her influence over the class.

In the case of computer as teaching tool, the teachers have integrated the computer into familiar teaching routines. They have not risked dramatic changes in teaching style that might undermine their ability to cover the curriculum effectively in an acceptable way, or to cope with varied demands if they are a learning support person. They have not risked their influence so it is secure over the core of the work. Meanwhile, the students' perceptions of the subject and of the teachers' capacity to use diverse methods are influenced by the use of computers within existing, familiar methods. No radically different methods have been risked; influence over core activity is protected and increased through what using computers expresses about the teachers.

It is quite reasonable that teachers act to protect their influence over core elements of their work, such as covering the curriculum and maintaining their credibility to do this. It is not surprising, for example, that teachers dislike ambiguous classroom situations where existing routines are in doubt and considerable time is required to deal with problems. Nor is it odd that teachers have to be very careful in the way they distribute support to individual students. There is only so much energy and so much time. But these protective strategies for maintaining influence may be used at some cost to the potential of microcomputer-based teaching, which may require that teachers learn to tolerate more ambiguity, increase individual attention, and engage in divergent thinking. All of these create risks for teachers. How are these risks to be managed?

Over-protection of these core elements may set a limit on what can be achieved through computer-based teaching unless teachers look critically at the way they exercise influence in the classroom. In the next chapter we consider how curriculum development and teacher education might provide contexts in which teachers can critically consider how they exercise influence in the classroom.

CHAPTER 4: IMPLICATIONS OF THE STUDY FOR CURRICULUM AND TEACHER EDUCATION

As we saw in earlier chapters, teachers are using computers both as a basis for teaching a new subject (variously called computer science or informatics) and as a teaching aid within an existing subject or teaching area like special education. These kinds of computer applications raise discrete problems for the curriculum and teacher education. We will treat each separately, beginning with computers as a subject.

COMPUTERS AS A SUBJECT

The Curriculum Perspective

Existing Conceptions of the Subject. In each of the four cases in which computers were used as the basis for learning a subject, the teachers stressed programming as the definitive activity of the subject (see also NEA 1983; Amarel 1984; Ragsdale 1982). Students studied the subject by being at the computer; their access was controlled by a rota system.

Programming took various forms but low resolution graphics and the use of utilities to produce such things as book titles and crossword puzzles were especially favoured. In two cases teachers thought that experience with various types of software was in itself a way to create computer awareness.

The teachers did not develop a formal syllabus for their computer awareness activities as such but were guided by the process of programming itself: what the children needed to know to operate the computer on their own. The informal syllabus enabled the teachers to pursue their goal of a self-taught subject. Occasionally, whole class lessons were given on key controls but, on the whole, the subject was taught through experience at the computer. How much time children actually spent at the computer, and hence studying the subject, depended on how many computers were available, how long each session was, which students worked in pairs, and whether or not they were able to take their turn or not due to attendance or denied access due to classroom behaviour. As well as formal access, there were chances for informal access during recess and lunch and after school. In this way, two children in the same class might end up with quite different experiences of computers as a subject.

Teachers thought that awareness was a direct function of time on the computer: the more time students were able to spend at the computer, the greater their awareness of it. This awareness was defined in terms like comfort, muscle control, knowledge of commands, typing skills, thinking skills, creativity. Such awareness was important, the teachers said, because computers were a new and important part of everyday life and employment.

Sources of Guidance. Teachers appear to base their approach to computer literacy on the idea that students should learn computer control and that guides to computer control could be found in the operating manuals, for example, the Apple Owner's Manual. Some teachers also used the "Apple Presents Apple" as a guide to computer use. Documentation accompanying various types of software is another source of guidance available to teachers.

One of the teachers has a computer at home, reads computer journals, and does programming herself. Another meets regularly with other computer users. All have taken computer courses offered either by the ministry or the board, or both. Two teachers have previewed material at Computer Place, part of the computer services located at the board. Sources of support identified by the teachers are outlined in table 9.

In the absence of a formal curriculum it would seem that these teachers are constructing a curriculum from their experience of computer courses and documentation available with the computer and software, as well as from their own experience in learning how to program. The computer subject, in the case of these teachers, seems to be almost entirely defined in terms of learning how to program the computer and operate various types of software. Generally, BASIC is preferred to LOGO as a way to introduce students to beginning programming. No systematic use of LOGO was seen in their classrooms.

The teachers found it difficult to teach the new subject for a number of reasons. Firstly, there are neither ministry nor board guidelines for computers in the elementary school. Secondly, teachers found it very time consuming to review the documentation that they used as a basis for computers as a subject. Thirdly, with just one or two machines, teachers wondered how they could reasonably teach computer as a subject at all in any fully developed way. All of the teachers wanted more machines, and two thought that there should be a computer expert teaching the subject, with the teacher playing a supporting role (see also Lartner 1983).

Table 9 - Sources of Teacher Preparedness

SOURCE	FREQUENCY OF MENTION	% OF MENTION
Colleagues	6	23
Visiting Computer Place (teacher centre)	4	15
Board computer course	2	7
Reading computer software documentation	2	7
Previous classroom experience	2	7
Helping other teachers	2	7
Magazines	1	3
Contact with developers	1	3
Other courses	1	3
Tutorials	1	3
Conferences	1	3
In-school computer course	1	3

Curriculum Issues. Many curriculum issues emerge from the cases, some of which move rapidly beyond the activities of these teachers to how we are to understand the place of computers as a subject in the whole curriculum. Nonetheless, the specific experiences of these teachers are important in understanding the difficulties of trying to incorporate the subject into schools from the teachers' point of view. There is a useful tension in what these teachers are trying to do. They think that computer experience ought to be a part of the students' education but they are not quite sure what form the new subject really ought to take, or how it could be included in the whole curriculum. As they see it, what they are doing is an unofficial, extra subject and they are unofficial teachers of it. The marginal status of the "subject" is clear to them, yet they echo the quite common view in their board, and among administration and parents generally, that computer awareness is a "good thing".

It may be a good thing, but its position in the curriculum in the elementary school is not clear. As it stands, computer awareness is an additional activity that teachers voluntarily take on and insert into the school day as they can. A computer station functions during teaching time based on a rota, and less systematic access occurs at other times.

Teachers give their time voluntarily to preparing work for in-class time and to monitoring students during out-of-class time. In return, they receive satisfaction from offering their students a variety of experiences that the teachers value and the students enjoy. For the library teacher, matters are a little easier: the computer subject becomes one element of the resources available in the library. In fact, the library setting might be seen as a transitional arrangement interposed between the classroom stations and the computer lab. These teachers want the computer subject established in some form and they want to play some role in teaching it.

The curriculum question is whether the subject should be established in the curriculum and, if so, how it might best be done. What do the experiences of these teachers have to say about these questions? A research report is not the place to argue for or against the establishment of computers as a subject in the elementary school. Were it to be established as a subject, a number of questions arise from the research.

1. These teachers have found it difficult to do more than introduce the rudiments of programming given the time and resources they now have. If they were asked to introduce computers, but without a clear mandate to take time away from some existing activity, how could they do more than they are doing now? Is what they are doing now enough to justify establishing computers as a subject? (see also Ontario Ministry of Education 1983).

2. If teachers were given class time but no additional equipment, how could they do more, given that "hands-on" experience of the computer is considered to be the way computers as a subject is to be studied?

3. If the preview of computer software is as time-consuming as teachers say it is, where are they going to find the time to become knowledgeable about and proficient in the use of software?

4. Given the demands on teacher expertise just to run the add-on activity they do now, is it realistic to expect teachers to take on an area that demands a high level of commitment and training?

5. If computers become a subject taught by specialist teachers with the commitment of time and resources that this implies, how is this to be justified given the arguments that can be made for improving the level of French language and science teaching in the elementary school, for example? How can computer as a subject be justified in relation to the whole curriculum and the existing areas that are thought to need additional resources?

Justifying computers as a subject. These are some of the questions that emerge from the present cases in which the computer is taught as a subject. Some may want to argue that computer awareness is best thought of as a desirable by-product of using the computer as an instructional tool, although some have argued against that (Ragsdale 1982). The main point to be stressed here is that the status of computers in the curriculum remains curiously vague. Arguments for computers as a subject in the elementary school (e.g., Clements 1985; Riedesel and Clements 1985) say nothing about the whole curriculum, only that computer literacy is important because computers "will be used in all areas of society, including education". The argument goes on to stress that children can learn from computers and shifts in focus from learning "about" to learning "from" computers; computers can help children learn, and therefore children should know about them. Such an argument really does not face up to the need for an independent rationale for computers as something to be learned about.

These issues remain entangled in this quite common approach to justifying computer literacy as a subject for schools (see Amarel 1982; Fisher 1984). The justification for learning with computers flows from the subject in which they are used. They are a tool whose purpose is defined by activities beyond simply studying the tool. Here issues about the whole curriculum are not critical because, for example, computers might help children learn English composition better, but English composition is already part of the curriculum.

But learning about computers, as a subject in its own right, is much more problematical and much harder to argue for. Curriculum time is a scarce resource; large investments in computers involve scarce dollars. How much time and money should be invested in computers in education? Is a vocational argument going to be fully persuasive? Such an argument might be that schools should prepare children for work: the work world requires computer expertise so school should provide this expertise. Or are there educational arguments to be made? For example, computers alter our way of life, our culture. Students should understand our culture and so they should understand the impact of computers on our culture; they should do this as a new subject rather than incorporate topics related to computers within existing subjects. Is this persuasive? How can computers be justified as something to be learned about and, if they can be justified, how can they be justified as the basis of a separate elementary school "subject"?

Fully developed, persuasive arguments for either of these views do not yet exist, as far as we can tell. We do not deny that such arguments could be made. Indeed, we think they should be made as a basis for curriculum development and teacher education if computers are to be a subject in elementary education.

There are two threads in existing arguments that need to be untangled. Arguments for the vocational benefits of learning about computers make certain assumptions about the functions of schooling that have to do with the socialization work of the school. How far should this function be promoted? If the school pursued all possible socialization functions, there would be no time for the critical, reflective activities associated with the educational functions of schooling. This is not to say that one function ought to exist to the exclusion of the other; only that these functions have to be balanced.

Educational arguments can be made for learning about computers that stress matters to do with the role of technology in our lives, with privacy, with the control of technology, and so on. These topics, of course, could be dealt with within existing subjects. It would look as if the main burden for creating a new subject at the elementary level would fall on the vocational strand of the argument, in which case one would have to look at the contribution early experience with microcomputers could make to vocational preparation.

Whatever decisions are made about the status of computers as a subject, there is a complex interaction between how the subject is rationalized, what resources are to be made available, what teachers can realistically do, what the impact on the rest of the curriculum will be, and what the overall educational advantages will be (see also Golby 1982). It is hard to see how it is possible to consider computers in the absence of a discussion of the curriculum as a whole and how that curriculum is intended to work in an educational way. It will be important to place the computer as subject in the elementary school in the broadest possible curriculum perspective, while at the same time attending to what teachers who have experience with the subject have learned as a way of assessing what realistically might be accomplished and if that is enough to make establishing the subject worthwhile.

Problem solving. The teachers place a strong emphasis on problem solving, in addition to the vocational value of learning to program the computer. Attaching the label "problem solving" to various school activities is not unique to the computer. Numerous school activities are said to enhance problem-solving skills. The difficulty with this rationale is that it is not clear, in the computer context, what problem-solving skills are, how computing contributes to such skills, and what evidence exists that such skills are indeed developed. If problem solving is going to be used as an important part of the educational justification for computers as a subject, then the term itself needs to be elaborated upon in relation to some theoretical understanding of how problem solving and programming might be linked, and in relation to research evidence that indicates that there is reason to think that problem-solving capacity and computing experience are linked. At the moment, use of the term seems to be quite vague.

Teacher Education Perspectives

Matters of curriculum and teacher education are closely linked. How the computer as subject will be taught -- especially now when guidelines are absent -- very much depends on what teachers know how to do with computers and on the different types of lessons they are capable of organizing. As in other subjects in the curriculum, there are questions about subject matter knowledge and about pedagogy at issue here, made quite complex by the indeterminate status of the subject.

From what we have seen in the case schools, there are clearly many teacher education issues at stake: teacher knowledge of programming; assessment of software; evaluation of student learning and of the program; methods of instruction using computers. We shall refer to all of these.

If the computer subject is going to be defined in terms of programming activity (and this is how these teachers see it), how skillful do teachers need to be in order to teach elementary school children the rudiments of programming? What programming languages are to be used? The teachers preferred BASIC to LOGO as a way of structuring beginning programming. One might argue that these teachers did not know enough about LOGO to make an informed choice and, indeed, as far as we could tell, none of these teachers had had much experience with LOGO. The fact that, based on the experience they did have, they preferred BASIC indicates something about what they think beginning programming should be like. They gave the impression that most children were not willing to explore LOGO on their own, and that use of LOGO would have required them to provide more support than they could have managed. Elementary exercises in BASIC were more self-supportive, but also created a demand for teacher support that they found difficult to meet.

Our point is that the teacher education question hinges very much on the way computers as a subject is set up in the elementary school. If the classroom teacher is going to operate with one or two computers in the home room, then what the teacher will need to know is quite different from a situation in which computer is a specialist subject taught by a trained computer teacher in a lab. The difficulties attached to the latter situation are of a different and lesser order from the classroom situation that we attend to here.

Let us imagine that a grant of time and resources is to be made in order to establish computers as a subject at the elementary school. How might classroom teachers prepare themselves for this responsibility? We might begin by asking what the teachers in the case studies have done.

Teacher preparedness. First, the teachers have all taken courses on computers in education; all have been given initial assistance from other teachers in their schools. In fact, an expert colleague is a major factor in initiating and sustaining teacher interest, as far as we can tell from these cases. The teachers all feel that more training in ways to use the computers in the classroom is necessary (see table 9). Secondly, these teachers have taught themselves how to program to some degree, and how to run and assess software. They have devoted considerable personal time to this process. As a result, they are familiar with a range of software types, as well as with the elements of BASIC. Thirdly, the teachers made room in the classroom in which to experiment with computers as a subject. It is important not to lose sight of the idea that they were experimenting with a new subject and with unfamiliar resources. Fourthly, as time went on, they talked to other teachers in their school about various problems in using the computer and received peer tutoring. Finally, they received institutional support from the board and the school in diverse ways: newsletters, visits from and to the board, encouragement and various forms of support from their students and the parents.

All of these activities have enabled these teachers to launch a particular approach to computers as a subject -- an approach that can be seen as an assimilation in practice of training opportunities, computer and software resources, and time. The approach they have used is a creative response to these conditions but is also limited by these conditions. What might be possible given that conditions could be amplified? In saying this, it is important to recognize that teacher education issues cannot be separated from resources and issues of time.

The rota-based "teach-yourself" approach that these teachers adopted represents, perhaps, a datum from which more extensive activities could flow (see also Fisher 1984; Amarel 1983; Judd 1983; Scanland and Slattery 1983). Their approach is a datum in the sense that it represents an adaptation of an existing method of diversifying classroom activity while minimizing demands for teacher support -- it is a "minimax" solution to a problem, if you like. The point here is that other solutions might be possible, indeed desirable, if conditions were improved. What might these be and what are the implications for teacher education?

An Agenda for Teacher Education

1. If there were more time, teachers could use whole-class teaching in order to expand subject activity beyond an introduction to programming (see Phillips et al. 1984). This presupposes that the teachers have access to curriculum ideas from which to develop classroom activity and that they know how to translate curriculum ideas into practice. In general, they are likely to be experienced at this but there may be specific areas of difficulty, such as using the computer for whole-class teaching.

   We had expected to find teachers using the computer as a focus of interest for whole-class teaching but found such activity to be rare. With a limited number of computers, teachers could engage the whole class in various awareness activities by using a computer at the front of the class. This assumes that teachers have access to high quality, large monitors

-- equipment we did not see in the schools we visited. This also assumes that "hands-on" activity is not the only mode through which educational objectives could be achieved.

Teacher education activity might involve both an analysis of computer-based whole-class teaching and the study of topics in computer literacy that go beyond work at the computer. As things now stand, teachers have neither an adequate curriculum basis for developing a computer literacy program, nor personal and classroom time to develop a range of teaching methods. Given the expressive goals teachers appear to favour (see the analysis of goals in chapter 3), the present "teach-yourself" approach may be adequate, but if the computer activity is intended to develop particular, evaluated competencies and understandings, then alternative pedagogies and a broader conception of the subject will be needed.

Whole-class teaching, using the computer as a point of departure, would require of the teacher skills in discussion leadership, in promoting problem solving and moral arguments, as well as the technical capacity to operate the computer while teaching (see Fraser, n.d.). These are quite high level competencies.

2. With respect to divergent thinking, teachers would need to have some framework for developing cognitive capacities like problem solving, and for assessing learning. Clements (1985) presents such a framework for preparing young children for programming. It is not clear, however, just how programming activity is linked with psychological theories about the cognitive processes involved in problem solving. This likely would be an important area for in-service course design, were the cognitive aspects of programming to be stressed in a computer-as-subject approach. It would form an important basis for developing approaches to student evaluation.

3. Teachers in this study were concerned about the time it took to preview software and to learn to manage software in the classroom. Clearly, how to preview software is an important skill in this context, and there is much development work needed here as a basis for pre- and in-service course design. These teachers were keen to obtain a variety of software and peripherals but unsure, it seemed, about how to build these elements into a systematic study of computers. Without a developed curriculum for this subject, selection of materials must remain haphazard, and developing criteria without a curriculum context itself must also remain haphazard, since the curriculum itself provides important criteria beyond technical issues to do with software and peripherals. Clearly the presence of a curriculum is a prerequisite for developing teacher education courses including courses on the selection and use of computer resources.

4. These teachers were very much interested in how children responded to computers and found considerable satisfaction in the positive responses of some children. Children's responses to microcomputers -- both socially as a part of classroom life and individually in matters such as practice, persistence, interest, attitude and so on -- are an important topic for teacher education (see table 10). The point here is that certain children respond quickly

and avidly to opportunities like microcomputers; others have a more diffident reaction, and questions about gender differences always exist (see Ridgway 1983). It is natural that teachers will be influenced by children whose interest is strong, but the full range of student response needs to be understood. This is a constant problem for teachers, who are generally adept at dealing with it, but the advent of microcomputers may pose special problems that need careful monitoring. We think here of fairness in access to scarce resources; sharing in paired use of computers; effectiveness of peer tutoring; monitoring progress; teacher support for different types of student problems; students' ability to deal with abstractions related to computer control.

At the moment, teachers are focusing attention on general matters such as overall class control, noise distraction, protection of equipment, evidence of high interest. They are evaluating their program in these terms. How to use such elements is certainly an important matter for in-service education but, if the computer subject is established, the detailed responses of individuals, pairs, and small groups will need to be considered, as well as the ways in which teachers now evaluate their programs. As we saw, teachers operated the "teach-yourself" approach; their concern was to minimize the support they had to give to children so that they could conduct work in the formal curriculum and run an extra subject as well.

Establishing the subject will require teachers to increase and differentiate their support for children as they engage in a more varied climate in which to learn about computers. How to do that with limited resources might be the most important item for teacher education agendas.

As we said, teacher education and curriculum are bound up together. How the computer as subject is conceptualized in the elementary school will have an important bearing on the agenda that is set for teacher education. The experience of these teachers is clearly the basis for their in-service education. They see that this is indeed one of the values of their willingness to experiment on a voluntary basis. They are able to profit from their own experience and they are looking to discuss that experience in a systematic way in the context of a defined curriculum for the computer as a subject. We have tried to point out in this section some of the curriculum issues that emerge from thinking about the computer as a subject and, from there, to consider what challenges teachers might have to face if the subject does become part of the educational functions of the school.

Table 10 - Student Reaction to Computers as Perceived by Teachers

ITEM	NUMBER OF TEACHERS MENTIONING ITEM
Students become excited and talkative when working on computer	4
Students co-operate in using computer	4
Students tend not to read instructions	4
Working on computer motivates students	3
Students forget control commands	3
Some students not machine oriented	3
Some student fool around with equipment	2
Students can help the teacher with computer problems	2
Students do not always use available computer time	2
Students do not pursue work as deeply as expected	2
Students have an improved attitude to work output	2
Students who often misbehave are good at the computer	2
Students will do routine work on the computer	2
Students enhance stature in class through computer expertise	1
Some students are easily distracted	1

COMPUTERS AS AN INSTRUCTIONAL AID

As we said in chapter 3, computers can be used within the boundaries of existing subjects as aids for teaching those subjects. Because the computer is being used within an existing subject, some of the questions about computers as a subject do not arise. Many other questions do arise and, in the end, they all ask for reflection upon the curriculum as a whole and the process of teacher development that is part of making that curriculum work for education. As before, we will deal with the curriculum first.

The Curriculum Perspective

We have to recognize the fact that each of the four cases we consider here involves the use of the computer in different subjects and with different forms of software. It is more difficult to see the general trends within these diverse practices but they exist nonetheless.

The major curriculum theme for computers as a teaching aid is that of integration. How is the computer used to achieve existing goals and what impact does it have on these goals through its effect on teaching methods and curriculum topics? From the theme of integration arise a number of questions about practice but, before we discuss these, it would be of use to review significant facts about how the computer is being used as an instructional tool.

1. At Winston School, Mrs. Thomas uses drill and practice activities in her special education class. She has to provide opportunities for extended repetition and she uses the computer to help her with this difficult task. With the computer taking over some of this work from her, she feels she is able to give "one-on-one" attention to her students. The computer is thus the teacher in another guise, as it were. She has found that certain students have been rather dramatically affected by their experience with the computer; it has made a sad child happy, for example.

2. At Crompton School, Mrs. Eliot uses the computer to stimulate interest in French. She is on the lookout for ways to encourage children to take an interest in the language; to work out what things mean. She has found that student interest in the computer is one way for her to spark interest in what might otherwise be seen as dull tasks by some students. She has found that her own approach to teaching French has changed because she has had to diversify her instructional approaches to incorporate the use of the computer. She feels that her approach to language activity has become more relaxed.

3. Mrs. Everett at Cambridge Middle School uses word processing as a way to improve student writing ability. She hopes that the ease with which revision can be made will encourage her students to correct their work so as to achieve a high standard of prose. She has found an interesting diversity of student responses to composition on the word processor, and feels she is more aware of individual student's approaches to composition than she was before experimenting with word processing.

4. Mr. Devon and Mrs. Melville at Albert Secondary School have used computers for tutorial work and for simulation activities. They have found that, through simulations, students are encouraged to think about geographical concepts in a problem context. They have also found that topics in the curriculum they used to cover have had to be abandoned in order to allow time for the computer work, which they feel makes a valuable contribution to student interest in and understanding of geography.

In every case, having to accommodate computer-based teaching has had an impact on the way teachers think about how they teach and how their teaching affects their students. The process of integration turns out to be more than a matter of assimilation of the technology into existing classroom practices; the goals of these practices have themselves been brought into question by the experiences teachers have had actually using the computer as a teaching aid. Thus, the use of the computer as an instructional aid becomes an occasion for reflecting upon the curriculum itself. Does the computer offer opportunities not yet embodied in the curriculum?

The subject/teaching areas we have before us are diverse and the answers to these questions are mostly case specific and would involve the teachers asking themselves in even greater detail what their computer experience signifies for the way they teach. Indeed, this very question is at the heart of our later discussion about teacher education. From a formal point of view, however, there are some interesting general points to be made about the computer as a tool in relation to curriculum.

Reconsidering practice. The ways in which the teachers have interpreted their experiences with computers suggest a concern for the processes they engage in and their impact on students. Experimenting with a new technology, in the way these teachers have done, shows us a way of testing assumptions about practice through practice. Curricula are made on the basis of certain assumptions about what and how children learn, and how materials can help them learn. By their very nature, curricula are policies to be tested in practice; there is little that is foregone in a curriculum.

In these cases, we can see how this is so because the teachers have made a relatively deliberate attempt to consider their own practice systematically in relation to existing curricula. Their experimental efforts with the computer are a form of action research into which we came as unanticipated but welcomed co-investigators. As in the case of computers as a subject, where teachers were testing out notions about a new subject, the teachers who work within existing subjects are themselves testing the validity of certain conceptions about what is important in what they do and how it should be achieved.

Take the case of simulations at Albert High School. Mr. Devon made it quite clear that he has had to change how he teaches geography in order to achieve certain process goals that he values, such as critical thinking. He has taken a different approach to classroom activity, and using computers has helped him do this. One of the consequences of stressing processes that he has had to accept is that less content material can now be covered in his geography program.

A further consequence of Mr. Devon's use of simulations is that he has had to engage in considerable local curriculum design in order to generate the seatwork material needed to support computer use; not all of the class can be at the computer. As a consequence of his experimentation with how to teach geography, his role in relation to the class has changed, as has the nature of his satisfaction.

The point here is not that using computers has brought this about, but that computers have been part of an approach to testing the validity of the curriculum by the teacher, in a way that leads to growth (see also Fraser, n.d.; Berg 1983; O'Shea 1984). We have here a potentially productive form of interaction between teacher, curriculum, and innovation that might be developed and elaborated in the context of thinking about how computers can be used as a tool for instruction. We are suggesting that the action research approach that these teachers, encouraged by their board, have adopted is an interesting model for testing out curricular ideas.

Take also Mrs. Eliot's approach to her French teaching. She has found that the computer has helped her implement changes in her approach to language teaching that allow for more diverse activities and a wider use of resources. She has made these changes because she has come to question the pressure she puts on students to achieve certain relatively narrow results in French.

Mrs. Thomas and Mrs. Everett have found that their experimentation with computers has led them to consider how their students respond to different ways of teaching. Their attention has become more focused on individual students as they ask themselves about the differential effects of instruction.

These cases show us that teachers found either that certain aspects of their practice were less important than they thought, or that things that they valued could be supported through the use of the computer. We are not suggesting that any profound changes in practice occurred in the process or that all that might have been achieved through a considered analysis of practice was achieved; we feel that there are many issues in the practices we saw that ought to be analysed further in order to gain as much as possible from the experience.

Software concerns. Some of these teachers and others in the other cases complained about the mismatch between software and existing guidelines. They were dismayed by what they saw as the lack of an adequate source of curriculum-specific software. This is not an uncommon complaint from teachers. What should we make of it? Firstly, there may exist software that they could use but are not aware of. Indeed, they said that it was difficult to get access to lists of software and, even if they did get access to such lists, it was difficult to tell what the software was about. Secondly, software may exist that is relevant to certain aspects of the curriculum but the teacher may prefer not to stress that aspect. For example, there are many divergent thinking type activities that could be incorporated into a language arts or math program but the teacher might prefer not to stress such processes. In other words, software might exist that relates to elements of the curriculum that the teacher does not favour. In this case, the teacher is making a comment about what he or she cares to stress in the curriculum. Thirdly, closely related software may not exist, but good software on topics that could be incorporated into the curriculum does exist; its use may require minor modification of the curriculum. Here the teacher is commenting on the extent to which he or she cares to be bound by the specifications of the curriculum. Finally, it could be the case that software does not exist or, at least, that nothing good exists.

There is a danger in too readily accepting that software ought to be tailor-made to fit curricula. Some software designers are experimenting with new ways of teaching subjects and with new topics. Their design work is a challenge to existing curricular policies and a challenge to teachers to explore these new ideas. We think that curriculum policies ought to be subjected to constant tests for educational validity and classroom realism, and non-tailored designs can serve that purpose. Of course, there must be some reasonable match between what the teacher is trying to do and the software used, but a productive tension between curriculum, teacher intention, and new ideas from outside can be valuable.

Stimulating student inquiry. Our final point about the curriculum has to do with the stress teachers place on creating stimulating environments for learning, and their own need for renewal. Their experimentation with computers seemed bound up in these two areas, perhaps at the expense of a more detached, critical view of what they were doing. We have to say that we met these teachers at an early stage in their experience with computers and would not suggest that they ought to rush prematurely to a more detached view. Implied in their search for a way of stimulating their students to learn is a concern about the capacity of the resources they do have, including the curriculum, to maintain the interest of their students. Their enthusiasm for the computer is bound up with the positive way children respond to being able to probe the resources of the computer, a relatively open-ended system. The pleasure some children take in being able to do this was in itself a source of satisfaction for teachers, and the new role they found themselves in vis-à-vis children and computers was a source of renewal. What do these reactions tell us?

Perhaps the computer offers an environment in which new ways of dealing with subject matter can be explored and new forms of teacher-student relationship can be established. We only glimpsed some of the possibilities here. The computer has an enormous capacity to serve individual interests in subject matter. It can help students gather, categorize, and analyse material that they have collected; it could revolutionize the project approach that is so common in schools by allowing students to manipulate information in a much more critical and open-ended way than ever before.

Indeed this is an approach much favoured by Mr. Walker, the computer consultant at the board. He argues for incorporating computers into the existing curriculum and using them to stimulate higher order thinking. This particular use of the computer, he said, represents its most important potential. Helping teachers see how it might be so is one of his priorities in teacher in-service education, for which he is responsible. He also hopes to produce booklets that would help teachers to incorporate the computers into subject teaching. He sees computer awareness as a process children go through to be able to use the computer as a teaching aid; for him computer awareness is not an end in itself, a subject for the school to develop. Computer awareness in this sense could be achieved in a very short time.

Beyond collecting quotes from reference books and photocopying pictures, students might begin to grapple more intellectually with material they have sought out according to interests and needs of which they may only be dimly aware. Perhaps the computer might offer ways of illuminating subject matter and creating the inquiry approach to schooling that has long been the dream of educators. In this sense, the potential of the computer poses a challenge to the way we now embody subjects in the curriculum. Teachers' experiences with using computers in their subject area become a way of testing out the validity of the curriculum resources they now have, and a basis for curriculum improvement. We think these teachers have begun to engage in such a process, if only tentatively. It is hard to predict where it will end up.

Teacher Education Perspectives

Implicit in the above discussion of curriculum matters is the idea that the critical analysis of one's own practice is a powerful educational process. In a sense this is what these teachers are seeking to do, both by attending courses and by their very willingness to experiment with microcomputers (see also Berg 1983; Signer 1983; Canning and Switzer 1985). Undoubtedly they have many reasons for volunteering to explore their practice but one important datum is that they have been sufficiently interested in new possibilities to petition for computer technology. The important question is, where do their efforts to find out more about microcomputers lead?

If microcomputers have the capacity to support important transformations in practice, then it is certainly worthwhile looking at what teachers need to know in order to achieve some of the potentials that microcomputers have to offer in education. How can this be done?

Curriculum context. The development of curricula needs to be done in sympathy with the educational potentials of information processing technology through formal and substantive means: formal in the sense that there is enough room in the curriculum to allow teachers to experiment with new ways of teaching their subject, and substantively through resource materials that suggest how microcomputers could be used creatively. There is a case to be made using case studies of stimulated good practice as a basis for informing teachers about potentials (see, for example, Jones 1982; Open University 1982). Perhaps now is a good time to think about how guidelines can portray the curricular potentials of new technologies and topics in existing subjects. The use of videotape to provide examples of good practice might be considered as resource material accompanying guidelines. Skills that teachers need are not new. They are the skills of transforming curriculum policies into practice and selecting appropriate means to achieve the purposes they seek (see Dehuka 1983).

This relationship between curriculum and teacher practice is not a one-way process. Unless those who develop curricular policies understand the context in which these policies are to operate, good ideas are going to be lost because of naïvety about practical matters. The risk is that the curriculum policy remains in "improbability drive" (Golby 1982; Worth 1985). Teachers need to be able to convey to curriculum developers articulate accounts of practical problems of coping in schools. Developing the very capacity to do this is an important agenda for teacher education.

The important potentials of the microcomputer as an instructional aid presuppose certain approaches to teaching that might be called open-ended or inquiry-oriented. The computer on its own is not going to create improved educational opportunities in schools. Only by its being used in a supportive environment can the computer come into its own. There are thus questions of basic pedagogy to be considered in relation to computer use, and management issues are very much in the minds of teachers (see Hartley and Bostrom 1982; Dehuca 1983).

Management. We see in these cases hints about the problems that teachers face in moving into more open-ended styles of teaching. Mr. Devon spoke about having to tolerate more apparent disruption in his classroom and having to develop flexible responses to unanticipated problems that come up as students work with complex programming activity and with a wide variety of software. He has had to change the way he teaches, he said. He has had to counter the students' desire for the "right" answer with encouragement to find out things for themselves.

Mrs. Melville has found that the ambiguous situations that confront her when students are using the computer have made her work more difficult. She has had to learn to diagnose more complex problems in her classroom and to be able to respond to a wider variety of demands on her, including many calls for support from students who are not sure how to proceed. Basic classroom management has been at issue and she has had to consider ways to adapt management procedures to cope with the demands of computer-based teaching.

In both of these cases, classroom management has been an issue. Clearly, issues to do with managing the microcomputer in the classroom are important for teacher education, perhaps even as a topic within introductory work on management at the pre-service level. An example of a specific important topic is the problem of reading instructions. Nearly all of the teachers commented on the failure of students to read instructions, either on the screen or in documentation. This is a serious problem because the teacher depends on students to do these basic steps for themselves in order for the teacher to cope with the complex activities that surround microcomputer use. To ensure effective transfer of information is a problem for the teacher, but also a problem for materials design.

Each of the cases indicates in various ways how management becomes a problem for teachers and hence an item for teacher education. These management problems are due partly to the self-directed nature of much of the computer-based work. Students are interacting with software and, depending on the software, may branch out in various directions. The teacher is often called in to support students but without being able to tell quickly where the student stands. This is indeed a difficult problem, and we found that not being able to diagnose and remedy problems quickly is an important concern for these teachers. We found that it was not the technical problems that were of most concern but ones to do with student learning and behaviour stemming from the interaction between variations in software characteristics and student abilities. These teachers, we found, tend to place a premium on maximum speed of diagnosis and minimum levels of individual student demands. Given class size and the scope of curricula, it is not surprising that this should be so. However, computer-based learning tends, at least initially, to reverse these variables, and teachers have had to adjust to this. The particular demands that computer-assisted teaching makes on the teacher in relation to existing management routines is, we think, an important topic for teacher education.

Student collaboration. Another factor affecting management strategies is the practical need for students to work together at the computer. The teachers frequently commented upon the various ways students interact with each other as peer tutors, as members of a team, and as collaborators. The teachers depended on and valued peer interactions (see also Hawkins 1982, 1983; Brine 1983). Using the computer as an instructional aid brings with it opportunities to increase the level of interaction among students, and it would be a valuable topic for a teacher education agenda. These peer interactions both increase the complexity of the management task while at the same time enabling the teacher to proceed with limited time and resources. It is a richly complex area worth action research on the part of teachers, itself a valuable form of teacher education.

Management issues form the backdrop to the central points about the computer as a teaching aid. If the computer has the capacity to support more open-ended approaches to teaching, what are some of the items for a teacher education agenda beyond management problems? (see Walker 1983; Simpson 1984).

Given a curriculum that supports an inquiry approach to learning, it is possible to imagine that the computer might play an important role in improving educational opportunity. How might this be so?

We can see already in the case of Albert High School that the computer is used to support a variety of open-ended approaches to geography. Mining is studied, in part, through a simulation of oil exploration; land use is studied through the interpretation of maps produced by the students from raw data. We can see here how the computer can support inquiry-based approaches to geography. Granted, these activities could have been done without the computer, but the computer has added a valuable extra dimension: it is able to process information quickly, deal with many variables, respond directly to student control, provide hard copy of personal project activity, and so on, not to mention the interest that it appears to generate in doing the work and in the subject itself.

The Future of the Computer as Instructional Aid

1. If we think of the computer as even more open to student interests in information processing, we can see yet untapped potential. What if students want to organize and analyse data in order to pursue projects, or word process in order to prepare reports or scripts, or create displays of information through graphics? With students spending significant amounts of time pursuing projects related to their subject, we can see how access to a computer might help them probe their work more deeply than before. The prospect is exciting. What would be required of teachers to support such activities and what might they expect by way of support themselves?

2. Projects are not an uncommon way of teaching, yet teaching students *how* to do projects is not that common in our experience. The management of information is not yet a topic in its own right. It would be worth looking at the nature of data base management, spreadsheet production, and word processing as a basis for teaching about information management; not only in its own right but as a way of studying school subjects in an intellectually powerful way.

3. It is clear that teachers are going to have to design material that incorporates desirable features of computer use. These cases illustrate the various ways in which teachers have had to design additional materials. If general information processing capacities of the computer are to be stressed, then teachers may well find themselves designing work sheets, project documents, and syllabuses that exploit the computer. Textbooks, in the short term at least, are not going to be that useful in the process. How to design such support materials becomes an important item for teacher education.

4. Teacher educators might want to consider these aspects of computer use as an agenda item within the discussion of existing school subjects, rather than only in computer courses. It would be helpful if teachers could see examples of the use of these information processing methods applied to their own subjects and could discuss the management implications, as well as the implications for goals of teaching that subject in relation to specific examples of practice. Videotapes of classrooms actually using these approaches might form part of the resource base for discussion, as might case studies that portrayed in a realistic way what it was like to work with information processing resources (O'Shea 1984). The danger for teachers is that these possibilities will be idealized and the agenda for teacher education will become unrealistic and adversely received by teachers.

5. What support might teachers expect? Time to develop the skills needed to use the computer effectively and study environments that are well matched to the needs of different teachers are important. The usual course on computers may not be the best way to educate teachers in uses of computers within subjects. Perhaps subject-oriented councils and associations should consider developing in-service activities that focus on computers as an instructional aid. Teachers may want time to engage in action research with peers and outsiders who have special research expertise. School staff may like to develop materials

to support computer use, and should have access to people who have experience in materials design and evaluation.

6. It would appear that significant commitments of time are involved here, as are reconsiderations of traditional forms of in-service education. Beyond this, there is the matter of software and hardware. What form of information processing packages might be most useful for different subjects? There is a need here for action research and development work. What types of computer configuration would be most appropriate for different subjects? Again, action research seems indicated. Clearly access to computers within classrooms may be important in some cases, while access outside of classrooms might be important in others, and a mix of these in yet others. Little is known about these matters. Such action research would be a valuable form of teacher education.

7. Above all, teachers need access to examples of practice based on the information processing capabilities of the computer so that they might have a basis for assessing their own practice in relation to the potential of the new approaches. Developing such examples seems to be of the highest priority.

8. Much hinges on the success of teacher education in exploring the curriculum, management, and instructional issues that surround the use of the information processing capacity of computers for supporting an inquiry-based approach to existing school subjects. A focus on the computer and its capacities in isolation from existing school practices would not be an adequate basis for achieving the educational potentials of the technology. The prospect of better subject teaching through computer use emerges from a rich set of traditional problems associated with more inquiry-oriented forms of teaching. This has long been a difficult topic for teacher education. The advent of microcomputers offers a new opportunity to look again at these issues but in a new, more complex context.

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APPENDIX A. SURVEY OF COMPUTER INTERESTED TEACHERS

The teachers we talked to in the study were all relatively familiar with the computer and clearly interested in computers in education. Obviously there are many other teachers in the school system interested and experienced in computers, and we designed a questionnaire to inventory their views on computers in the classroom.

We obtained lists of all classroom teachers (excluding those we had already talked to) who had attended computer use workshops at the Computer Centre during the months of January to March, 1985. We sent the questionnaire to every other teacher, making the sample a total of 55 people. (See appendix B(j), p. 70, for details of the questionnaire.) We received back 36 responses, making our response rate 66%. Of the responses, 62% were from people who had used a computer in their classroom during the year; 38% had not used one in their classroom. Of the responses, 76% were from elementary teachers and 24% from high school teachers.

The questionnaire was developed after we had talked with computer-experienced teachers and was intended to provide further information about how teachers view the potential of microcomputers in education, what equipment they think they need and where they see difficulties. Clearly our sample is small and the comments that follow are intended more to provide a background to the case studies than to make claims about computer interested teachers as a whole in the school board.

EDUCATIONAL POTENTIAL OF MICROCOMPUTERS (Table 11)

All sub-groups ranked word processing most highly, but drill and practice was seen as being of equivalent value. Teachers who had not used computers in their classroom and high school teachers ranked information retrieval more highly than those that had used them. Programming as a computer-based activity rated low in all cases. Overall word processing and drill and practice were dominant, with information retrieval and simulation in the middle. Least important was programming. Teachers in the case study who were doing computers as a subject did tend to favour programming activities, however.

These were teachers considering what the most valuable educational uses of the computer were. Perhaps in many cases teachers had relatively little familiarity with information retrieval uses and with simulation, and were not able to locate these accurately on the scale. In other words, familiar activities are rated highly because they are known. This picture would easily change as teachers become more familiar with educational uses of microcomputers.

DESIRABLE EQUIPMENT (Table 12)

Teachers in both sub-groups preferred to have another computer and a printer over a large monitor and a colour monitor. Given the interest expressed in word processing, it is not surprising that a printer would be preferred to a colour monitor. The result also fits with what our case study teachers said about their use of microcomputers for word processing and the value of hard copy as a record of effort and a basis for creative writing.

Both teachers who did not use computers in their room and high school teachers were less interested in having a large monitor in their room, and overall the large monitor took a definite second place to more computers, although costs are comparable. Our case teachers also showed little interest in large monitors. Such monitors, especially high resolution ones, give the teacher the chance to engage the whole class in what is going on at the computer -- a chance to communicate with the class using the computer. This is not something teachers seem to want to do as yet preferring to let the computer operate one-to-one or with small groups. Accordingly, whole areas of possible interaction with the computer seem ruled out. Such use of computers does not rate highly with teachers, as we shall see in the next section.

Table 11 - Teacher Rating of Types of Educational Uses of Computers

	Word Processing	Drill and Practice	Information Retrieval	Simulation	Programming
Used Computer in Classroom (N=23)	x=1.9(1)*	x=2.35(2)	x=3.7(5)	x=3.1(3)	x=3.5(4)
Did not Use Computer in Classroom (N=13)	x=2.17(1)	x=2.17(2)	x=2.59(3)	x=3.17(4)	x=3.17(4)
Public School (K-8) Teachers (N=28)	x=1.92(1)	x=2.32(2)	x=3.48(5)	x=3.16(3)	x=3.36(4)
High School (9-13) Teachers (N=8)	x=2.14(1)	x=2.14(1)	x=2.57(3)	x=3.0(4)	x=3.43(5)

* Rank is shown by the numbers in brackets

Table 12 - Teacher Preferences for Equipment

	Want Large Monitor and Stand OR	Want Additional Computer or Disk Drive, Mono Screen	Want a Printer OR	Want a Colour Monitor
Used Computer in Classroom (N=23)	4	16	18	3
Did not Use Computer in Classroom (N=14)	2	11	13	1
Public School (K-8) Teachers (N=27)	5	20	24	3
High School (9-13) Teachers (N=8)	1	7	7	1

COMPUTERS AS A SUBJECT (Tables 13 and 14)

Since we found computers taught as a subject in half of our case studies, we wanted to find out what other teachers thought about this use of computers.

We found that the teaching aid use rated most highly across all sub-groups, and computers as stimulus for classroom discussion least highly. Computers as a subject did not rate highly as a computer-based activity. However, when teachers were asked directly whether learning about computers as a subject should be part of the K-8 curriculum, they tended to support the idea, especially high school teachers and those who had not had computers in their room during the year. Teachers who had had computers in their room were evenly divided on the question. As we noted in the body of the report, the present status of computers as a subject in the K-8 curriculum is ambiguous in a way that it is not in the high school. Teachers who had used the computer in their classroom tended to favour the use of the computer as a teaching tool and not favour programming the computer as a computer-based activity. We suspect that teachers' interest in computing itself plays an important role in influencing their views about the computer's educational use. This is an area that might be explored further.

Table 13 - Teacher Rating of Computer-Based Activities

	Computers as Subject	As a Stimulation for Classroom Discussion	Drill and Practice	As a Teaching Aid
Used Computer in Classroom (N=23)	x=2.48(3)*	x=3.35(4)	x=2.0(2)	x=1.78(1)
Did not Use Computer in Classroom (N=13)	x=2.31(2)	x=3.54(4)	x=2.46(3)	x=1.62(1)
Public School (K-8) Teachers (N=28)	x=2.36(3)	x=3.61(4)	x=2.07(2)	x=1.61(1)
High School (9-13) Teachers (N=8)	x=2.63(4)	x=2.75(3)	x=2.5(2)	x=2.0(1)

* Rank is shown by the numbers in brackets.

Table 14 - Preferred Status of Computer as Subject in K-8 Curriculum

	Should Learning About Computers Be Part of K-8 Curriculum?		
	Yes	No	No Response
Used Computer in Classroom (N=23)	10	10	3
Did not Use Computer in Classroom (N=13)	10	13	0
Public School (K-8) Teachers (N=28)	15	11	2
High School (9-13) Teachers (N=8)	5	2	1

HESITATIONS ABOUT USING COMPUTERS (Table 15)

We asked teachers to give reasons for hestitating to use computers. We grouped the reasons into six comprehensive categories. For both sub-groups, adverse effects on classroom routines and curriculum was the category with the most comments. Teachers said they were concerned about students missing other lessons and being distracted by others using computers. Lack of time to include computer work along with other curricular responsibilities were mentioned. Teachers who had computers in their classroom appeared to be more concerned about equipment and space problems than those who had not had a computer. These findings are in line with what the case study teachers said about the difficulties of using computers in the classroom.

Table 15 - Types of Problems Giving Rise to Hesitation to Use Computers

	Lack of Knowledge	Lack of Software	Adverse Effects on Class Routines/ Curriculum	Lack of Equipment/ Space	Lack of Support	Misuse
Used Computer in Classroom (N=23)	2	4	6	6	1	1
Did not Use Computer in Classroom (N=13)	1	2	5	1	1	3

APPENDIX B. RESEARCH PROCEDURES

RESEARCH ACTIVITIES

(a) Background Documentation. Since 1983, a large suburban school board has been promoting microcomputers in the classroom through a pilot project scheme in which teachers interested in using computers in their classroom are invited to apply for computer hardware. In each case, the teacher is asked to draw up objectives, procedures, and formal methods of evaluation for the pilot project.

This pilot project scheme provided us with a framework in which to conduct this research. On the basis of our analysis of interim and final reports from schools awarded project hardware, we selected eight schools -- five K-5/6; two 7/8; one 9-13 -- that would provide us with a range of computer applications across divisions.

A discussion was held with the board officials responsible for the planning and implementation of the pilot project in order to gain insight into the board's rationale for the introduction of computers, the scheme's progress, and the parameters within which both they and the teachers involved are required to operate. The computer consultant was interviewed in detail concerning the pilot project.

From an analysis of the documentation, our discussion with board officials, and an extensive literature search, we drew up a semi-structured preliminary interview to be used with the school principal and/or computer co-ordinator (see (b) below), and an in-depth, computer-specific context interview to be used with the classroom teacher (see (d) below).

(b) Preliminary Interview. In order to gain access to the schools and to introduce the project and its researchers, a letter of introduction and a project outline were sent to the principals of all eight schools, and an interview was requested. Each principal was also asked to introduce the project to the school's staff and discover whether the teacher(s) involved in the pilot project(s) would be willing to participate.

The preliminary interview with the principal was designed to obtain a clearer idea of the "computer context" in each school by exploring factors such as how the school's interest in computers began, the progress of these projects from the principal's point of view, the reactions of staff, students, and community to computers in the classroom, and future plans for computer use. Although a standard questioning routine was followed, this preliminary interview was designed to be fairly general and the atmosphere relaxed. In two instances, after a brief interview, the principal referred us to the school's computer co-ordinator as a more knowledgeable source of computer-related information.

(c) Classroom Teacher Questionnaire. A short questionnaire was developed to gather specific data on the educational and computer background of the teacher and students and on the computer equipment being used in the classroom. This was distributed along with a project outline prior to our first meeting with the teachers and collected during the context interview.

(d) Context Interview. The context interview with the classroom teacher was designed to elicit in-depth information on contextual factors affecting classroom computer use: the teacher's history with regard to computers; the demands of the pilot project; management issues affected by the presence of the computer in the classroom; the limitations and advantages of classroom arrangements; availability and quality of software; reactions from students, staff, and community. A total of twelve teachers from eight schools were interviewed. These interviews were audiotaped and transcribed, and were later used to design the projective interview (see (e) below).

(e) Projective Interview. Using Kelly's (1955) repertory grid technique, we designed a research instrument consisting of 25 statements, each on a separate card, describing typical microcomputer situations. These situations were based on actual classroom situations or incidents described by teachers in the in-depth context interview and were those thought to be particularly useful for probing teachers' approaches to classroom computer use.

Each of nine teachers was shown the 25 situations or "elements" and asked to group them according to some underlying commonality. The groupings were then discussed in detail and the common theme, or "construct" defined. From this process emerged some assumptions, important to that particular teacher, about classroom order, management, educational objectives, teacher and student roles, and the place of the computer in the classroom context. The teacher was finally asked to rate each element according to each construct on a seven point Likert-type scale.

This projective test allowed us to probe the basis for decisions that underlie practice and provided a basis for understanding the interests that teachers pursue through these decisions. The teachers' responses were analysed and used to prepare a final, structured interview (see (h) below), and a wide-scale classroom computer use survey (see (j) below).

(f) Computer Use Journal. Since we felt that it was both important and necessary to somehow match the teachers' practice with their espoused theories of computer use, but available time and resources would not permit long-term classroom observation, a computer use journal was devised. Its aim was to get each of the nine teachers to record a sample of typical classroom computer use.

The journal, in a log format, asked the teacher to describe one computer-assisted learning (CAL) activity per day for a period of five consecutive days. In addition to factual information, such as name of the software used, duration of the activity, number of computers used, computer location, and related lesson topics, the teacher was also asked to record the purpose of using the computers in this instance, the management of the activity, and any observations about the ways in which the students worked at the computer.

(g) Videotape Commentaries. On the basis of our interviews with the teachers, we approached five teachers whose activities represented a variety of computer applications. The aim was to understand in greater depth what it meant to a teacher to have a computer in the classroom. It was arranged that we should videotape students at work on the computer(s) and ask them to comment on what they were doing as they worked through a program. In addition, we wanted to capture any management moves on the part of the teacher that involved the computers and/or the students working on them.

After a number of experiments with the equipment, we devised a system where we could both film the student at work and record information directly from the computer screen onto the videotape. This allowed us to switch from the student to the program so that, as the student took us through the program, we were able to record his or her progress too.

Following the videotaping exercise, the teacher was invited to view the tape and comment on what the students were doing, what they were saying about their work, and specific classroom procedures. This commentary was audiotaped and the data analysed.

(h) Summative Interview. Data obtained from the context interview, the projective interview, the computer use journal, and the videotape commentaries were used to prepare the summative interview. All nine teachers participated. Each one of these final, in-depth interviews was individually tailored to the teacher being interviewed. In each case, the focus of the interview was on those points of particular interest to us arising from the teacher's practice, such as the relationship between goals and actual practice, the integration of computer use with the curriculum, management issues, and teacher/student roles and responsibilities within the classroom. These interviews were recorded and transcribed.

(i) Project Seminar. All teachers who participated in the research project attended a meeting to discuss the project's preliminary findings. The occasion was used as an opportunity to test with the teachers themselves our emerging hypotheses about why teachers use computers in the way they do.

(j) Microcomputers in the Classroom Survey. As a further check on our emerging hypotheses, we used teacher concerns arising from the projective interview as a basis for surveying fifty-five computer-using teachers from the same board of education.

BACKGROUND DOCUMENTATION

School: ____________________

Address: ____________________ Tel.# __________

Principal: ____________________

Teacher: ____________________

School Data

1. K-6 ☐ K-8 ☐ High School ☐

2. English ☐ Dual-Track ☐ Immersion ☐

3. # of Students ☐

4. # of Teachers ☐

	#	Make	Board
Computers			
Disk Drives			
Monitors			
Printer			

	#	Board
Joystick		
Koala Pad		
Other		

	#	Board
Graphics Pad		
Mouse		
Other		

Set-Up: ____________________

____

____

Pilot Projects: ____________________

____

____

PRELIMINARY INTERVIEW OUTLINE

I	INTRODUCTION:	Purpose of meeting	- introduce research project learn history of pilot project
		Min. of Ed. project	- purpose methodology
		Board's interest	- progress report confidentiality supply teachers
		Purpose of teacher interviews Principal's interests/concerns?	
II	PILOT PROJECT:		
	HISTORY:	When) How) did involvement begin? Why) Why particular hardware requested? Why these particular projects?	
	PROGRESS:	What do you see going on now? What do you think about this? What do you see as advantages/disadvantages? Any changes to original plans?	
	REACTIONS:	From staff?	- age differences - increased p.d./in-service
		From students?	- age/gender differences
		From parents/community?	
III	BOARD:	Why do you think they initiated this? Stimulus/follow up?	
IV	OTHER PROJECTS:	Does school computer use pre-date pilot project? Original initiative for this beginning?	
V.	FUTURE:	Plans for pilot project? Projected idea situation?	

CLASSROOM TEACHER QUESTIONNAIRE

Teacher: ______________________________ School: ____________________

TEACHER DATA

1. Subject specialty (if applicable) ☐

2. # of years teaching experience ☐

3. # of months/years (please delete) at this school ☐

4. # of months/years (please delete) using computers in the classroom ☐

5. What formal training in the area of educational applications of computers have you had? (List courses, workshops and duration).

______________________________ ______________________________

______________________________ ______________________________

______________________________ ______________________________

______________________________ ______________________________

______________________________ ______________________________

6. Do you have any programming experience?
a lot ☐
some ☐
none ☐

7. Were you involved in the planning of the 1984-85 board pilot project?
yes ☐
no ☐

8. Were you involved in a 1983-84 board pilot project?
yes ☐
no ☐

9. Do you subscribe to/regularly read (please delete) a computer magazine?
yes ☐
no ☐

CLASS DATA (If applicable)

10. Grade ☐

11. # of students ☐

# of boys ☐

# of girls ☐

13. How many students have computers at home? ☐

14. Is there a computer in your classroom . . . . .

all the time ☐

part of the time ☐

never ☐

If the computer(s) is only there part of the time, ☐

for how long? ☐

EQUIPMENT DATA

Please list the computer software you use in your classroom (if applicable).

Please fill out the section below regarding equipment you use in your classroom

	#	Make
Computers		
Disk Drives		
Monitors		
Printers		
Other		

CONTEXT INTERVIEW

I. INTRODUCTION:

Min. of Ed. project - purpose
methodology
Board's interest - progress report
confidentiality/supply teachers
purpose of context interviews
[what you're doing]
[how and why you're doing it]

II. HISTORY OF COMPUTER USE:

How) did you get involved with computers?
Why)
How long have you been using computers in your classroom?
Who made the decisions?

III. PILOT PROJECT:

When)
How) did your involvement begin?
Why)
Were you involved in decision making?
Who made decisions?
Role of other staff?
What has pilot project contributed to your computer use?

IV. NOW:

How are you using the computer now? [activities]
[prog.]
[software]
[subjects]
[schedules]
Change from original plans? If so why?
Describe the physical set-up.
Any physical constraints affecting computer use?

Describe classroom routines - class work
gp/pair/one
Raised new management issues?
easy or challenging?
Changes computers have made in your role as T?
Computer whiz kids?
What are your goals for students on computers?

What is noticeable about ways students work on computers?
Any carry-overs?
What kinds of activities complement computer work?

How do you feel about what's happening now?
Limitations? Constraints?
What kinds of things have pleased you?
Not so pleased?
Your successes?

Source of guidance/ideas/support?
Reaction to mechanical breakdown?

V. SOFTWARE:

Your opinions of available software?
What makes good software?
Who chooses it?
On what criteria?
Role of accompanying materials?
Any way software different from other resources?
Preparation for using software? previewing? reading?

VI. REACTIONS:

From students?
- different ability levels?
- age/gender differences?
What do you make of it?
Any memorable incidents?
Describe specific kids.

From staff?

From parents/community?

VII. BOARD:

Why initiated pilot project?
Concept of pilot project.
Extent of board support/follow up?

VIII. FUTURE:

Plans for computer use? Pilot project?
Ideal situation for computers in classroom?
Advantages/disadvantages?
Advice for other teachers?

PROJECTIVE INTERVIEW ELEMENTS

1. A student has crashed a program and has asked the teacher for help.

2. Some students are talking with a pair of students working on the computer and distracting them.

3. A student needs help on the computer and a computer-experienced student offers to help.

4. Something has gone wrong with the computer and impatient students are waiting to use it.

5. The tutorial program a student is working on gives an answer the student does not agree with. The student calls the teacher over.

6. Students are using a music program. Other students stop their work to listen.

7. As planned, two students leave the classroom to work on the computers in another part of the school.

8. Some students are asking to spend their recess at the computer.

9. One student is doing all the work on the computer while the other one watches.

10. One student does not want to work with another student at the computer.

11. A student tells the teacher she is bored with the software she is using.

12. The teacher is instructing the class but a pair of students working on the the computer are very excited about what they've managed to do and want to tell the class.

13. A student doing word processing says she's shy about people seeing her work and asks for the machine to be moved.

14. Students ask for more of their work to be based on the computer.

15. A pair of students have not completed their work on the computer in the allocated time. They want more time.

16. A long line of students has formed at the computer waiting their turn.

17. Students rush their seatwork in order to get back on the computer but then get into difficulty and need the teacher's help.

18. Some students are way ahead of the rest of the class on the computer. They are asking for new work.

19. A boy tells another student to hurry up and finish at the computer. The student objects.

20. A pair of students are working very slowly through a computer program and when asked why, say they do not understand the instructions.

21. A student brings in an arcade-type game disk from home.

22. During a math drill a student is deliberately feeding in wrong answers to see what the computer will do.

23. A student did not hand in work due at the end of a lesson but now wants to take his turn on the computer.

24. A student doing a spelling tutorial is persistently getting the answers wrong.

25. A student who misbehaved during class time is asking to use the computer during recess.

Construct: A : | B :

DOES CONSTRUCT APPLY TO CLASSROOM SITUATIONS?

CLASSROOM SITUATIONS

#	DEFINITELY APPLIES	APPLIES SOMEWHAT	WEAKLY APPLIES	WEAKLY APPLIES	APPLIES SOMEWHAT	DEFINITELY APPLIES	NOT RELATED TO A & B
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							
13.							
14.							
15.							
16							
17.							

Construct: A : | B : (continued)

DOES CONSTRUCT APPLY TO CLASSROOM SITUATIONS?

	DEFINITELY APPLIES	APPLIES SOMEWHAT	WEAKLY APPLIES	WEAKLY APPLIES	APPLIES SOMEWHAT	DEFINITELY APPLIES	NOT RELATED TO A & B
18.							
19.							
20.							
21.							
22.							
23.							
24.							
25.							

MICROCOMPUTERS IN THE CLASSROOM PROJECT

GUIDE TO COMPUTER USE JOURNAL

We would like to sample a typical week's computer use. Please tell us about one of your CAL activities* each day for five days (more if you like).

If you use the same CAL activity each day (and no other), simply describe it once and then circle the days that you used it on the same form.

1. PURPOSE: What were students to learn from the computer-based work? How was the computer activity related to the subject area program? Or to "computer awareness"? Or to other purposes for CAL you had in mind?

2. MANAGEMENT: How was access to the computer determined? How many students used the computer(s)? What written work did they produce, if any? Was this assessed? Who required help? Why? Was there seat-work associated with the computer activity? What other management matters had to be attended to?

3. OBSERVATIONS: Your impressions of the computer-based session? Observations of students: how did they react? How did you and they interact? What were the positive elements of the CAL? Negative? Comments on software?

*'CAL activity' = a computer activity during which the same or a very similar piece of software is used. (This may be as short as 20 minutes or so, or as long as an entire day.)

MICROCOMPUTERS IN THE CLASSROOM PROJECT
COMPUTER USE JOURNAL

DAY: 1 2 3 4 5 (circle one)

TEACHER:____________________ SCHOOL:____________________

CAL ACTIVITY:____

SOFTWARE TITLE: ____

TYPE OF SOFTWARE: drill tutorial simulation LOGO graphics
(circle one)

adventure puzzle word processing

SUPPLIER: ____

DURATION OF ACTIVITY:____

# OF OTHER CAL ACTIVITIES DURING DAY:____________________________

# OF COMPUTERS USED:____

LOCATION: ____

PRINTER: (circle one) Used Not Used

SUBJECT AREA/GRADE: ____

RELATED LESSON TOPIC: (if any)________________________________

1. PURPOSE OF COMPUTER ASSISTED LEARNING (CAL) ACTIVITY

2. MANAGEMENT OF CAL ACTIVITY

3. OBSERVATIONS ON CAL ACTIVITY

VIDEOTAPING PROCEDURE

1. Videotape beginning of lesson

2. Pick up teacher management moves

3. Briefly interview students who are using the computer.

Sample Questions

What are you learning on the computer?
How does the computer help you to learn?
Can you show me how you learn?
Do you always work on your own?
How have you got to use the computer today?
What work have you done before that helps you do the work on the computer?
How often do you work on the computer?
What do you like best about working on the computer?
What do you like least about working on the computer?

4. Pick up any change over at the computer

5. Pick up any interaction between student and computer and other students and teacher.

6. Pick up end of lesson.

TEACHER COMMENTARY:

Sample Questions

1. What is the purpose of this work on the computer?
2. How is it related to the subject?
3. How is this work scheduled?
4. How do you monitor what the students are doing?
5. What impression do you get from what this student is doing?
6. What do you do when students are having difficulty?
7. How did you decide who works on the computer today?
8. How do you feel about this child's attitude to work on the computer? Is this typical? What is the significance of this?

MICROCOMPUTERS IN THE CLASSROOM SURVEY

Name: ______________________ School: ______________________

Background Information

1. Years of experience ______________________

2. Grade(s) now taught ______________________

3a. Type of School:

K-5/6	____________	English	____________
K-8	____________	Dual Track	____________
*High School	____________	Immersion	____________

3b. *High School subjects taught ______________________

4. Do you have a computer at home?
YES ______
NO ______

5a. Have you had a computer in your classroom in 1985?
YES ______
NO ______

5b. If yes, for how long? ______________________

5c. If no, has your class gone elsewhere in the school for computer activities?
YES ______
NO ______

5d. If yes, how may times since Jan. 1985? ______________________

6. If you used computers for instruction in 1985, please describe the major type(s) of activity.

____
____
____

7. How would you describe your familiarity with using computers for instruction?

____
____

Your Opinion about Computers in Education

8. If you were given (or now have) one computer, disk drive and screen, and useful software for your classroom, which of the following ways would you prefer to use your system? (Please rank order 1, 2,3, placing 1 against your first preference and so on)
   a) To learn about the subject of computers and computing ____________
   b) As a basis for engaging the whole class in discussion ____________
   c) As a way of offering drill and practice ____________
   d) As another way for students to be taught certain concepts ____________

Please give a brief reason for your first choice:

____
____
____
____
____
____

9. If you had (or how have) a 64K computer, disk drive and a green screen and you could purchase additional equipment, what would you choose? (Please place a tick opposite your choice)

i) Choose ONE of the following:
   a) 26" colour monitor and tall stand ($1,500) ____________
   b) another computer with disk drive, green screen and table ($1,500) ____________

Please give a brief reason for your choice:

____
____
____

ii) Choose ONE of the following:
   a) a printer ($500) ________
   b) a colour monitor ($500) ________

Please give a brief reason for your choice:

____
____
____

iii) Choose ONE of the following:
- a) a utility program that enables you to make up crossword puzzles and other handouts ____________
- b) a drill and practice program in a subject you teach ____________
- c) a program for keeping track of student grades ____________

Please give a brief reason for your choice:

10. What would be, for you, the most important reason for using computers in the classroom?

11. What might be the most important reason to make you hesitate to use computers in your classroom?

12. Do you think learning about computers should become a subject in the K-8 curriculum (with a local guideline of topics as in other subjects)? Please comment:

13. Please rank order the following uses of the computer in terms of what each has to offer to the education of your students. Place 1 opposite your highest ranking (most valuable) choice and so on.

a. word processing __________
b. drill and practice __________
c. information retrieval __________
d. simulation __________
e. programming __________
(e.g., LOGO, BASIC
low-res graphics)

Please comment on your first choice:

____
____
____
____
____
____

Thank you for completing this questionnaire. Please place it in the envelope and send it back to us by the end of May.

Sandra Eaton
John Olson
"Microcomputers in the Classroom" Project
Queen's University

APPENDIX C. CASE STUDIES

COMPUTER AWARENESS IN THE LIBRARY:
WOLSEY PUBLIC SCHOOL

1.0 SETTING

1.1 The School

Wolsey Public School is a small K-5 suburban school with approximately 175 students and 12 teachers. For the past two years it has had in the library two Apple IIe computers under the supervision of the teacher/librarian, Mrs. Hughes. One of these computers was given to the school under the board's one-per-school policy and the other was requested under the pilot project scheme.

The pilot project application was drawn up at very short notice by the principal and Mrs. Hughes, who at that time was a Grade 4 classroom teacher and the only teacher in the school interested in computers. It was Mrs. Hughes who took the initiative to involve the school in the pilot project scheme. The objectives for the pilot project included staff and student awareness, developing a series of K-5 computer activities, providing word processing and programming for exceptional children, and greater staff involvement in the use of computers. Mrs. Hughes, nevertheless, felt that she could not assess the feasibility of such objectives without the actual experience of using the computers with the children. At this stage, her priority was to obtain the second machine rather than to strictly adhere to objectives drawn up in haste and with relative inexperience. Due to the limited time lines for planning the project and submitting an application, the other staff were not consulted but rather the project was presented as a fait accompli.

The two computers are in the library and teachers wishing their students to use them book a slot on a timetable posted on a weekly basis in Mrs. Hughes's office. Staff are also free to book the computers for use in their own classrooms although this rarely happens. Students are encouraged to use the computers at recess and lunch hour but this is organized using a computer pass system: each day four students are issued a pass by their classroom teacher so that they can use the computer. The classes rotate on a weekly basis. Most of the staff have participated in a computer professional activities day and interest is beginning to grow, although the rest of the staff generally seems content with the present system under Mrs. Hughes. Response from the community has been "extremely positive", with parents lending either software or their time to the school, and sometimes consulting Mrs. Hughes as to which computer hardware and software they should purchase for a home system.

The principal is keen that his school experiment with computers. He feels that this is one more way in which school can be made interesting for his students and is very pleased with the way in which students have responded to Mrs. Hughes's initiatives. He describes the school's investment in computers as "nothing but win, win, win". He is concerned, however, about the value and effect of computers in society on a large scale and does not feel that this issue is sufficiently addressed by those responsible for promoting the educational use of computers. He suggested that there may be a tendency for children to become "addicted" to computer use to the detriment of their social skills, but he has not seen any evidence of this in school. Mrs. Hughes does not share this concern, pointing out that student interaction is one of the most noticeable things about children's computer use.

Both the principal and Mrs. Hughes feel well pleased with the project and plan to apply for six more computers (three Apple IIe, two Apple IIC, and one Macintosh) and a colour printer for next year.

1.2 Teacher Biography

Mrs. Hughes has taught for eighteen years through grades 1-6. She began her job as teacher/librarian at Wolsey two years ago, at the same time as computers were introduced into the school. Prior to that, she had been a Grade 4 teacher at the school. In 1983, falling enrolment meant a reduction in the number of Grade 4 teachers but, coincident with this, the board decided to allocate a half-time librarian to small schools such as Wolsey. Mrs. Hughes volunteered to take on the responsibility for the library because she had always been interested in it and because it had already been decided that the computers would be based there. Her present responsibilities work out at half-time librarian, quarter-time remedial/enrichment and computers, and quarter-time physical education, art, health, and music.

In 1982, while still a Grade 4 teacher, Mrs. Hughes became interested in computers. She borrowed a Commodore Pet 2001, which was sitting unused at the board office, on a one month loan. She renewed the loan at the end of that and subsequent months until the computer became a permanent feature in her classroom. She had very little software for it and basically allowed the children just to play with it. At this time, she began to develop her interest by taking a four-week introduction to computers course, and she has since taken an eight-week course in beginning programming and the ministry's computers in education, parts I and II.

1.3 Equipment

The Commodore Pet 2001 remains in the school, in the resource room where it is still widely used by the classroom teacher. The library has two Apple IIe systems, one with a double and the other with a single disk drive, each with two screens -- colour and green -- and each with an Apple printer. There is also a koala pad and a joystick. Both systems are bolted to mobile tables.

1.4 Software Used

Mrs. Hughes has a fairly extensive collection of software across all the grades, which she says she has obtained by various means from various sources. She determines which software the school will acquire and aims to get a good variety of software at each grade level. She tends to concentrate on programs in language arts, mathematics, and thinking skills. Such programs include "Bank Street Writer", "Crossword Magic", the Houghton Mifflin math series, "Facemaker", "Oregon Trail", "Sticky Bear ABC", "Explorer Metros". She also does low-resolution graphics. On a number of occasions, at a teacher's request, she has written her own drill programs -- for example, a drill on the provinces of Canada, and rivers of the world -- but she feels that this is too time consuming when there is plenty of good commercial software available.

She favours software in colour and looks for programs that are "idiot-proof" and can be operated relatively independently by the students. Particularly at the lower grades she avoids software with complicated instructions since these are usually above the reading level of the students and represent potential frustration. Most of the software she chooses can be used by pairs of students although some is designed for individuals. Another criterion is variety: some students respond well to bells, beeps and congratulations, others needs a quieter approach.

She frequently uses students for a preliminary evaluation of new software, both to save her time and because she feels that students know good software when they see it.

2.0 COMPUTERS IN ACTION

2.1 How the Teacher Is Using Computers

Mrs. Hughes combines her responsibility for the computers with her duties as librarian. She keeps an open timetable on her office noticeboard and teachers can come in and sign students up for either the library or the computers. If the computers are being used by another class, the teachers are still welcome to book their students into the library and vice versa.

Usually a teacher will send down four to six students from a class at any one time. These students might be selected according to a rota or more usually because they need extra practice in a particular subject or because they are ahead of the rest of the class and do not need the lesson being taught. The kindergarten and Grade 1 teachers, however, bring their whole class down once a week on a regular basis. The class is split into two, one part under the supervision of the teacher, the other with Mrs. Hughes. Computer passes are available at recess and lunch hour and are allocated to a total of four students a day by the classroom teachers. The library is also open on Tuesdays after school.

Mrs. Hughes summarized her original goal for the school as "computer awareness" and "hands-on" computer experience for every child. Before the present system of use was established, every student in the school went to the library for a computer orientation, an introduction to the machine. At the beginning of this year Mrs. Hughes repeated the process for the incoming students and any other new students to the school: "I tell them the parts of the computer, how they operate, how to turn them on, what not to do, and this kind of thing; how to put a disk in, kinds of programs....I call it awareness." To encourage the youngest grades to use the computers she initiated a "Sticky Bear Certificate" scheme. The certificate was awarded to students who could demonstrate that they had learned the above skills.

Mrs. Hughes goals for this year are, she feels, "a little more focused" as she learns what is feasible: she has expanded her notion of awareness to include making students aware of the "graphics capabilities" through LOGO, low-resolution graphics, and the koala pad. She has already taught low-resolution graphics to grades 3, 4 and 5. As she teaches art, she taught the program as an art project to the Grade 3 students. The students first drew their pictures on squared paper, then worked out their program and entered it into the computer. This proved to be very time consuming and not every child got as far as entering the program into the computer before the project was over. Mrs. Hughes did not find this disturbing for, as she explained, they all completed their original picture and "they were made aware that these things can happen, that the computer can do, can respond to things they tell it to do." With the Grade 4 and 5 classes, low-res graphics coincided with the math curriculum: "It was a follow-up to a graphing lesson" and an opportunity to teach "programming and thinking skills". Again, students drew a picture on graph paper, wrote a program and typed it up. This time every student completed his/her computer picture. The only drawback was that the programs were in colour but the school's printers only print in black and white. Mrs. Hughes did try to run off a couple of programs on the board's colour printer but was disappointed by the colour quality.

We asked Mrs. Hughes to give us a sample of a typical week's computer use. Software used included "Sticky Bear ABC", a drill used by a small group of kindergarten children to "reinforce lessons taught in the classroom"; "Explorer Metros" and "The Factory", simulations used by small groups of Grade 5 students, including an enrichment group; "Bank Street Writer" word processing, again for Grade 5 students; and "We're Counting on You", a drill in decimals for Grade 3 students who were considered by their teacher to need the extra reinforcement. In each instance the students were under the supervision of Mrs. Hughes who also taught any additional concepts the children required to use the software. Mrs. Hughes explained that, although she can usually match students' needs with the software, a computer program will occasionally present the concepts in a different way from the classroom teacher. She then steps in to review the concepts as they are presented in the software.

Mrs. Hughes's enrichment group has been using "Bank Street Writer" and various utility programs to produce a school newspaper. These students are allowed to use the computers whenever they are not in use, even if Mrs. Hughes is not there. Since they are the older, brighter, and more responsible children, she trusts them to use the machinery and software sensibly and independently.

Choice of software is often left up to Mrs. Hughes although a teacher sending a child or children down to use the computer will frequently specify exactly what kind of work the student(s) should be doing, leaving the actual choice of software to Mrs. Hughes. They request "things that fit in with what they are doing". Others will specify exactly which programs their students should be using. At recess students are allowed to choose which programs they would like to use but Mrs. Hughes classifies all the available software as "educational".

The computers are on the list of resource equipment that a teacher can sign out of the library for classroom use. This has rarely happened however. "Last year I had them down at the office for a while, the secretary was trying out different programs, and then one of the teachers took the computer out but none of the other teachers felt the need for that. It was so much easier having the distraction away from the classroom." One teacher does use the computers in the library while Mrs. Hughes is teaching in the classroom. He uses the computer stations as one of several activity centres that are in the library.

Most of the time the computers are Mrs. Hughes's domain and the teachers use her as a "resource person". She therefore does most of the supervision of students working at the computers. She finds this easy to do because, even when she has a class in the library, she is always on the spot. Supervision is therefore not a problem but it is a priority: "I don't think kids should just be plugged in front of a computer and left on their own." Whenever there are children using the machines she is very conscious of the need to monitor them, even if she does not need to intervene: "I hover around but I don't interfere." As the students are generally only on the computers for twenty minutes, time is precious and Mrs. Hughes is anxious that they do not waste it unnecessarily. On the other hand, she feels that it is valuable to allow the students to solve problems for themselves.

2.2 What the Teacher Is Trying to Accomplish

Mrs. Hughes's goal was and still is "awareness". Each year she has ensured that there is no student in the school who has not had hands-on experience on the computers. However, she has given the responsibility of determining who will use the computers to the classroom teacher and recognizes that there may be some children who have not used the computers since her school-wide computer awareness campaign at the beginning of the 1983-84 school year.

She feels that it is important for children to be comfortable with computers even at the kindergarten level because of the future impact she believes computers are going to have on society.

> I think that living in the society that we're living in, we're being unrealistic if we tell the kids they don't need this sort of thing, or if we tell parents that they don't need this sort of thing because chances are that, no matter what they do, they will indeed have some kind of contact with computers. . . . Your bills and everything else . . . are computerized. So it isn't something that is going to just disappear. Now the technology will obviously change by the time these kiddies are there, but I think that they shouldn't have a fear of the machines.

She also feels that students should not be deprived of tools that will make their lives easier, even in school. She mentioned the children who have difficulty with their handwriting, children for whom the monotony of drill and practice is considerably lessened, and children who have memory problems as examples.

When asked what she felt the students were learning from using computers, apart from familiarity with the machinery and programs, Mrs. Hughes replied that they were learning both typing skills and an awareness of the computer's capabilities. Throughout our interviews, however, she continually stressed the importance of developing students' thinking skills. She feels that programs in which the students are required to create programs, such as low-resolution graphics and LOGO, are very good training but admits that she does not know how to measure whether a change in thinking skills has occurred.

> I can't really judge whether the kids have really picked up anything from the computer in the way of changing their thinking skills or brain patterns, or learning habits, or whatever you want to call it because I really don't understand how we can judge that sort of thing. . . . I see the kids here, working on some of the programs that involve logical thinking . . . where there are certain kinds of steps that you have to follow. . . . I've read Mindstorms and I think that's terrific . . . but I don't really know how they are going to judge that. . . . I can expose them to those kinds of things, let them use them, but when they go back into the classroom, if their thinking is different and they're handling the program differently, I really don't know. . . . I can't see if there's been any transfer.

Another of Mrs. Hughes' priorities is to offer a useful "service" to other teachers. She sees her role as computer-innovator as an extension of her librarian role: just as she prepares or collects materials for a unit a classroom teacher is planning to teach in her role as librarian, she provides computer resources for remedial and enrichment activities as computer resource person. In order to do this effectively the other teachers need to know what kinds of software are available. Mrs. Hughes gives regular reports at the twice monthly staff meetings and provides software updates by distributing, via teachers' mailboxes, photocopies of the manufacturer's brochure for any new software that the school acquires. This may be accompanied by a few words from her on its potential uses. As Mrs. Hughes has taught across all the K-6 grades during her teaching career, she has a good idea of where software fits into the ministry guidelines and will recommend particular programs to particular teachers she feels might be able to use them.

When asked to summarize her achievements over the last two years Mrs. Hughes said:

> Firstly, I've learned to use a heck of a lot of new programs. I've made a lot of contacts in the board to find out what's available. I've made quite a few of the teachers aware of what's available and more comfortable with the computer, even parents. . . . As for the kids, I think they've enjoyed the experience and I think that's the big thing, that you do a

> positive thing for them, and I think that, in many cases, it's helped them.

2.3 Factors That Influence Computer Use

2.3.1 Equipment/Software. According to Mrs. Hughes, two computers are insufficient to do anything on a large-scale. The limited number more or less dictates the basis on which the machines can be used. She would like to increase the number of computers to around seven so that she could increase the scope of her program and include more programming, but she is a little vague as to what other purpose she thinks this might serve. She likes the idea of a lab.

> I would be interested in taking one class at a time, and doing some work with them as a group, like LOGO for instance. Whereas with only two computers, you can't do that. I mean you've got to go through it constantly, and there just isn't the time available. . . . Whereas if we had a lab with five or six computers you could do that very easily. And I would like to be able to do that.

2.3.2 Teacher Preparedness. As previously described, Mrs. Hughes has spent a lot of her own time learning about computers through various courses but she feels that this time investment has been worth it because she wanted to do it. She does feel quite strongly, however, that more effort should be put into staff training by the local board. She is at Wolsey School to help the other teachers if they so wish, but many teachers in other schools do not have someone at the scene on whom they can rely. Mrs. Hughes also appreciates that the principal's support and encouragement have made her work possible.

When asked if she could give any advice to teachers wanting to experiment with computers in the way she has done, she felt that willingness to learn from experience was the most useful advice she could give. She also advised sharing the learning with the children and watching them carefully to see how they respond to programs. This provides a good indicator of which programs should be purchased.

2.3.3 Students. Students' enthusiasm has been very high, which, for Mrs. Hughes, is one of the rewards of using computers: "The kind of pleasure that they get out of it gives me pleasure." Although her overall goal for the school is computer awareness, no compulsion is exerted to involve those students who are not interested. Such students, however, are few. There are always students eager to come in at recess, lunch hour, and even after school to try out programs or show Mrs. Hughes some program that they have been working on at home. She feels that she can provide an appreciative audience for them, and they in turn can assist her on occasion when she perhaps cannot figure something out. Although this aspect of the teacher/student relationship is a little new, because for the first time the students see her as a learner too, she feels that this is essentially just another facet of the relationship she tries to establish with the students.

> I don't mind asking kids to help me with things that I have a problem with. I've never had a problem doing that. It's just that it hasn't quite originated in the same way as with computers, because it's something that is new for me as well. I think it's new for most of the kids as well . . . but we talk about books, or whatever, and discuss things that we're doing at home. So it's easy to come and talk. I enjoy that kind of relationship with kids so I don't think it's any different.

Mrs. Hughes does feel that it is important to match software as far as possible with individual students. As Wolsey is a small school and she has been there for several years she knows most of the students and finds that she can usually adapt programs to students fairly successfully:

> in the classroom you know there are some kids that need a lot of structure, and some of them can handle all kinds of things but some of them just can't handle bright colours and lots of goings on. . . . That's why some kids are special. . . . It's the same for software. You have to be careful as to what kids you're going to put on what software. Some of the MECC software is very plain compared to some of the new things that are coming out, and yet it is exactly what some of the kids need.

2.3.4 The Curriculum. Mrs. Hughes does not see the awareness work she is doing as "teaching computers". Teaching programming is just another way of teaching "thinking skills" and drill and practice is just an extension of work that goes on in the regular classroom. Increasing students' "comfort level" through "exposure" to the machinery, software, peripherals, and various computer applications, and decreasing their "fear" are seen as a kind of service that she can offer.

> They're being made more aware of the computer and the capabilities of the computer to help them, and, if we think realistically, by the time they get out into the workforce, they'll be required to know how to use a computer in many, many jobs, have experience and be comfortable with it. . . . It's got to be made available to them.

2.3.5 The System. In the first year of the pilot project the board allocated its pilot project schools with $1,000 to purchase software. Of that, $800 was for the purchase of software determined by the board. This enabled the school to acquire a large amount of software without any capital outlay, except for blank diskettes. Unfortunately, Mrs. Hughes considers that much of the software supported by the board was neither as popular nor as useful as anticipated. In the second year of the project the school was allocated $750 for the purchase of software and given a free rein in selecting which programs would be suitable.

Both Mrs. Hughes and the principal feel that the concept of the pilot project is a good one but that the time limits and amount of paperwork are "ridiculous". The principal is also concerned that vast amounts of money are being spent on computer innovation without due consideration of the educational objectives. Although Mrs. Hughes appears well satisfied with the quality of service she receives from the board, the principal feels that the follow-up has been poor. No one has ever visited the school, for example, to see how the computers are being used, or whether they are being used at all.

The nature of the pilot project has also, superficially at least, determined computer use policies in the school: "We thought that 'awareness' in a small school like this was one which would be an easy objective to follow through on because if they were going to evaluate the project we didn't want to take one which was going to be more than we could handle."

COMPUTER GRAPHICS IN A PRIMARY PROGRAM:
ELLESMERE PUBLIC SCHOOL

1.0 SETTING

1.1 The School

Ellesmere is a K-6 school of 330 students and 17 teachers in the suburbs of a city. There are five computers in the school: one Apple II+ purchased with funds raised by the school; two Apple IIe computers that were provided by the board in 1983 under its pilot project and one-per-school schemes; an Apple IIc and a Macintosh provided for the 1984-85 pilot project. All computers are on trolleys so that they can be wheeled from class to class and can all be locked away at night.

Computer use at Ellesmere began with the purchase of the Apple II+. The decision to introduce computers was initiated by the principal, Mr. Spicer, with the support of his staff. This computer was kept in the staffroom for experimentation, but teachers began to borrow it for classroom use and for experimenting at home over weekends. No formal, systematic approach to computer use was adopted and individual teachers were left to decide whether they wanted to use the computer in school or not. Student use of the computer tended to be limited to drill programs or games if they finished their work early.

Mr. Spicer said that one of his teachers had submitted the original proposal to establish a pilot project in the school. Miss Somerset, a Grade 3 teacher, had submitted a proposal when she was at her previous school but, when she moved to Ellesmere, she brought her project with her and began it at her new school instead. Her computer project is the major computer activity in the school. So far, there has been one visit from the board to look at the progress of the pilot project.

Mr. Spicer no longer sees himself as taking an instrumental role in promoting computer use, but he is very pleased with what he sees going on in the school. He wants students to be introduced to computers and hopes that teachers will use computers in a variety of ways. He is concerned, however, about access to the computers. He feels that all children, not just "gifted" students should be exposed to the challenge of the computer. He also wonders about the extent to which the computers are being integrated into the on-going teaching. He believes that computers are something teachers will have to face sooner or later. Some teachers have attended board workshops and there have been a few in-school training sessions: Mr. Spicer is determined that the school will not lose the progress already gained.

1.2 Teacher Biography

Miss Somerset has been teaching for eighteen years and has been at Ellesmere for four terms. Her interest in computers began in 1981 when she heard that the board was founding a computer centre, Computer Place, at a local teachers' centre. It was there that she began to explore computer applications. She finally volunteered to help other teachers who wanted to try out the equipment. She then took a programming course in BASIC at a local community college and later bought her own computer, an Apple II+. Since then she has begun to develop her own educational software, which she is marketing through her own company, and has started an educational bulletin board for teachers in North America.

In 1982, while still at her former school, where she was a kindergarten teacher, she applied for a pilot project computer but was turned down, so she went ahead and bought a TI99A to use with her kindergarten class. She found the TI computer and its modules very useful for the little children because the modules were durable and well-protected and the keys were plastic. At around the same time she started writing software for her Apple II+ -- drill and practice exercises like "Less than, Greater than". She then brought her Apple computer to school so that students could do the exercises. She re-applied under the pilot project scheme for the 1983-84 school year, deliberately choosing a project that she thought would be acceptable to the board: using the computer for creative writing and in connection with film-making projects. She changed schools during the summer of 1983, the summer that she was awarded the pilot project computer.

At Ellesmere she was to teach not kindergarten but Grade 3. Over that summer she made up seatwork activities for the students in advance, using the computer, and then compiled them into a workbook. She then took all the spelling words out of their language arts book and entered them in a spelling program, "Magic Spells". Although she has a pilot project Apple computer in her classroom, she still uses her TI computer for drill and practice activities, using modules like "Milliken Addition". The Apple computer is used for programming and word processing.

She would like to have at least fifteen computers so that she could run an entire program using the computer. She feels that this would be a very interesting experiment but would require managed programs that would allow her to monitor students' progress. This would save her having to "mark all those math questions. The computer would do it all for me."

1.3 Equipment

Miss Somerset still uses her TI computer, particularly for math drills, but she also has access to at least one of the project computers. Last year this meant the Apple IIe but this year the Apple IIc and the Macintosh are included. The TI remains in her room, but the other computers, which she must book, are wheeled in at the start of the day. She tries to book as many computers as possible, to both increase access and give her students experience using different types of machinery. The computers are arranged down two sides of her room with the screens facing inwards. She also has two koala pads and would like a modem to enable her class to link up with a class in British Columbia.

The day we went to observe Miss Somerset's class she had a total of four computers in the room: the TI computer, an Apple II+, an Apple IIe with two screens and a printer, and the Macintosh.

1.4 Software Reported Used

"MacWrite", rather than "Bank Street Writer", which she also has, tends to be used for word processing. Other software includes "MacPaint", "Micros Made Easy", "Sensible Speller", and the Sunburst "Challenge Math" series. The programming language "Applesoft BASIC" is used for low-resolution graphics. For the TI she has programs such as "Milliken" math, "Hangman", and "Early Reading". Software that she uses for her own classroom purposes includes "Print Shop", "Word Search", "Crossword Magic", "Appleworks", and "Compumark".

2.0 COMPUTERS IN ACTION

2.1 How The Teacher Is Using Computers

Miss Somerset begins the year with "basic lessons on different parts of the computer" and a few demonstration lessons using "Bank Street Writer". Last year she spent a lot of time on her pilot project, combining creative writing, Super 8 film-making, and the computer.

> We used "Apple Mechanic" to create titles. We printed the titles and the credits off the monitor. They wrote their scripts on the word processor. They worked in groups of six. After they had their scripts ready, they converted the scripts into a story board with pictures. . . . From there we decided what materials they were going to use; whether it would be plasticine, cutouts, and different types of things like that. They made all the little creatures and cutouts and what-not, and we filmed them on a Super 8 camera. After that they chose an appropriate piece of music -- background music. We put that on the second track of the film and then we went back and they would read the parts while we ran the film. We would find we had a little bit too much of this-- so we would go back to the word processor and reword some parts and record the voices on the film.

In addition to this she introduced the students to loops, data, and "GOTO" statements used in programming. The students were given a copy of the listing for a graphics program, "Musical Massage", and asked to come up with suggestions as to how the colours were represented and controlled. Once they understood how this was done, they attempted to alter the colours of the design for themselves. They were also encouraged to experiment with the shape of the design. Their new designs were recorded on a VCR and the students chose background music, which was then recorded onto the sound track.

This year Miss Somerset is running the film-making with her regular Grade 3 class and with students in the extended program who are from grades 4, 5, and 6. She is using both the Macintosh computer and the Apple IIe.

Another change this year is the involvement of another teacher, Mrs. Brookes, with the creative writing aspects of the pilot project.

> We wanted to see if there was a higher creativity level when they were using the word processor than if they were writing stories by hand. What we thought we would like to do is give each child thirty minutes to write a story on the word processor. We were originally going to have them do three stories and then take the average number of words per story. We were going to measure the creativity level by the number of adjectives and adverbs in the stories.

The two teachers were particularly interested in the writing done by the Grade 4 students who were in Miss Somerset's Grade 3 class last year. They wondered whether these students' extra experience on the computer would have a long-term benefit in terms of creativity. "At the end of the year we hope to be able to see that the kids who had not previously been using the word processor had increased their level of creativity by the end of the year. I am not a researcher and I know it is not going to be statistically significant . . . but it will give us a general idea." Time limitations have subsequently meant that this mini-research project has had to be substantially modified and Miss Somerset is not sure what she has been able to learn from it.

The major computer activity of this school year for her Grade 3 class has, however, been low-resolution graphics using "Applesoft BASIC". She anticipates that it will last until the end of the school year. Although she does not feel that Grade 3 students need to be able to program, she sees this graphics work as developing computer literacy and tying in with the Grade 3 curriculum on plotting co-ordinates. The students were introduced to the programming commands as a whole class lesson. Miss Somerset was worried that programming graphics might be too difficult for her students and that when she introduced the control commands the students might not understand, but she found that they did learn. She had them sit on the floor in front of the computer watching as she demonstrated how to create a picture. She used the two monitors and "we talked about how we could create vertical lines and horizontal lines". She asked them to tell her how they might translate co-ordinates from graph paper to computer.

Although the students are now well into programming their pictures, Miss Somerset thinks she might have a lesson on what a "syntax error" is and how they can correct errors in their programs. Students seem to have difficulty with "syntax error". She gave them a lesson on "FOR-NEXT" loops to create a block of colour but thought that it might have been too difficult. She thinks, however, that a majority understand what a variable is.

Students are usually assigned to work on the computers by rows, "skipping students whose assignments are incomplete or whose classroom behaviour has been inappropriate". Each student works individually for approximately twenty minutes at the computer when his or her turn comes up. Students usually collect a print-out of their work before returning to their seats. After each turn on the computer they are supposed to record how long they were using it and which pieces of software they used. These statistics are for the board. In order to facilitate computer use, much of the class work is divided into group work, multiple reading groups, for example, Miss Somerset works with one group while another uses the computers. The other groups work independently at their reading. Miss Somerset's students are not allowed to use the computers during recess or lunch hours, which are times set aside for students from other classes to use them.

The day we observed Miss Somerset's Grade 3 class, some students were doing low resolution graphics work on the Apple IIe, using the colour monitor and the printer. Others were using "MacPaint" on the Macintosh to create symmetrical designs. Others were using the Apple II+ and the TI computer for drills. We videotaped the graphics work.

The first student we observed, Sarah, was creating a dog. Miss Somerset described Sarah as a student who regularly finishes her work. She has an Atari 800 at home but does not program on it. Sarah came over to the computer without the picture of her dog, which she had previously drawn on graph paper, and the program, which she had previously written, so Miss Somerset came over to help her with the colour of the eyes. She then suggested that Sarah put a collar on her dog, which Sarah attempted to do. Sarah ran her picture on the printer when she had finished. It made a considerable noise. Miss Somerset remarked that this was a constant worry: it was a distraction for the rest of the class and she wondered whether in fact it made them hyperactive.

Michael was next on the computer. He was having difficulty entering his co-ordinates so Sarah stayed to help him. After Michael, came Lien. Lien had left both her picture and the written version of her program at home where she had been attempting to program it on her own computer. She proceeded nevertheless, on a trial and error basis.

Lien was followed by James, a winner at computer games who was nevertheless finding low-res graphics difficult. He had to take every line a step at a time. Sarah came over and helped him too. Miss Somerset thought that he perhaps lacked self-confidence where this kind of work was concerned and was nervous about not being able to do it.

After James, Marie came to the computer. She had spend an hour previously mistyping "H lin" and "V lin" and was not aware that she had been typing her program in the wrong way. She had not run her program so had not received an error message. She had been typing from a sheet and had had no way of checking her error until Miss Somerset noticed what she had done. Miss Somerset felt that these were some advantages to this kind of trial-and-error learning, such as developing problem-solving skills. Marie did not seem to mind that she had mistyped her program.

During one thirty-minute period Miss Somerset came over to the computer about four times. She had to come over so frequently to help because the students had not quite mastered the work.

She reported that the students will ask her for help if they know they are stuck but she also encourages them to help each other. She remarked that other computer work requires much less monitoring. We asked Miss Somerset how she kept track of where students were in their computer work. She said, "I can't keep track. I am frequently just absorbing it by osmosis!"

The students do not show their work to each other in a formal way since there is not usually sufficient time for this but Miss Somerset does show examples of students' work in her computer literacy "mini lessons" that she has two or three times a week. A lot of things end up being done incidentally: a couple of minutes discussion with the class about certain problems rather than an entire lesson on computer use. She tries to keep track of the problems they are having and so eliminate the monitoring demands on her. Such mini lessons are held at the side of the classroom using the small monitors.

Despite her enthusiasm for computers in the classroom, Miss Somerset does have a number of concerns. She is very conscious of the noise that the computer printer makes and the noise that her classroom organization encourages, for example the noise students make as they do their seatwork while she teaches the reading groups. She was very sensitive to the classroom noise that she heard on our videotape. She had also been recently watching the children when a student teacher was teaching and had noticed that many were not paying attention but were "playing with their toys". She wondered whether she might be encouraging too much interaction between students. She is worried about losing control as a consequence. She mentioned that, whenever she leaves the classroom, students tend to become immediately disruptive. Despite this she feels that the benefits of the computer outweigh the problems, although she has had occasion to take the computers out of the room when the noise level has risen too high.

She is also concerned that students do not read what they see on the screen, instructions for example. They then get into difficulty and require assistance from either her or other students. She felt that this might be improved through a series of problem-solving activities that would encourage students to listen and read.

Despite the fact that she intends low-resolution graphics to run until the end of the year, Miss Somerset is concerned that it might not be justified. She worries that they may be wasting a lot of time. She has attempted to link this program to the Grade 3 curriculum through graphing activities, such as plotting co-ordinates, but admits that some students may not complete their pictures by the end of the year. She sees the actual computer programming "as a synthesis activity. It's a much higher level. They've done it on paper [plotting the co-ordinates]. It's like an application exercise . . . . You'd need a computer for each child to make sure they all had the experience [of programming their graphics]."

2.2 What the Teacher Is Trying to Accomplish

Miss Somerset thinks that drill and practice on the computer is more stimulating than doing the same as seatwork: students are getting immediate feedback and are learning how to type.

Beyond CAL, she feels computer literacy is important because computers are going to be a "major source of information for them in the future and I think elementary school is as good a place as any to start." She feels that students ought to become familiar with the computer itself as a form of technology. They can learn about what a computer is like and how it works. Literacy for her is the ability to use software rather than knowing how to program, although literacy work does include graphics programming. The computer, as she sees it now, is an extra· "It's not on the curriculum. I have the responsibility to have them do all these other things. This is something extra right now. I feel that if they are not keeping up with the basic work they are responsible for, then there is a withdrawal of privilege." Miss Somerset thinks that students' work on the computers has some link to the curriculum but that its main contribution, beyond literacy, is to increase problem-solving skills and to increase students' creativity. As she said, "it's a good mental activity". She said that it is a thrill for students when they find they can do something different, something new, something creative. They also enjoy it.

2.3 Factors That Influence Computer Use

2.3.1 Equipment/Software. Miss Somerset has access to four different Apple computers (II+, IIe, IIc, and Macintosh) but sometimes has to negotiate with other teachers to ensure that she gets the computers she wants for the particular activity she has planned. She has found that students get confused when they go from one computer to another. She gave the example of working with "Bank Street Writer" on the Apple IIe and the II+: the program does not run the same on these two machines.

She has found it difficult to locate the equipment in the classroom so that the other students are not distracted by what is happening at the computer. The noise of the printer is a problem, as is storing the computers. Each day her computers have to be taken to a storage place, which is crammed so full of computers that there is not room to run off a stencil or get paper out of the cupboards.

She would like programs that manage instruction, that keep track of the children's progress, and score their tests. For this she feels she would need access to a lab of about fifteen computers. Yet she also thinks the computer should be in her classroom so that the "kids see that this is part of their environment, that's it's part of their life. I'd hate to see it isolated into one location. And then I feel in order to develop literacy, the only way to do that is by having a lab set up with someone who is trained to teach those skills."

She would also like a modem so she could share information with other teachers and other schools, so she could link her class up with another Grade 3 class in B.C. that has a modem, for example. She described in some detail her efforts at home to link up with other users and the educational bulletin board she operates. She sees many uses for this bulletin board: "We could have quite a bit of dialogue going back and forth between schools: sending letters, sending pictures and things they [the students] had created. We could create a puzzle or an adventure and see if the other group could solve it."

She is also intrigued by the possibility of "Smooth Talker", a program for the Macintosh. She found the students very interested in typing in stories and having them pronounced. No female voice is as yet available, however.

Miss Somerset likes the durability of modules for young children: disks are so delicate. She is concerned about the problem of replacing damaged software and of having enough disks to use on her computers. How are these issues to be resolved without spending large sums of money on software? Word processing on the Macintosh, for example, is limited by a single disk drive, which means that students have to shuffle their disks, causing great confusion. When students do not each have their own disk, saving their work also becomes difficult.

2.3.2 Teacher Preparedness. Miss Somerset feels she has actively pursued her interest in computers at home. She has attended computer conferences, given workshops, kept up-to-date through access to bulletin boards and through previewing software. She has also started her own educational bulletin board and begun to develop software. She has taken a course on programming in BASIC.

In her view, teachers need to have a computer at home so they can preview software and learn their way around the system. She has been helped by the board's Computer Place teacher centre where she has become familiar with a variety of computers.

2.3.3 Students. Effective control of the class is an important issue for Miss Somerset and she is concerned that because of the way she has had to organize her class to use the computers, control might be at risk. Students are excited by their work on the computer, she said, and this is not always easily handled. She feels that computers lend themselves to students talking to each other, to helping each other. There is lots of consultation but if it becomes too loud she has the students return to their seats. She does not want the students to think they can consult each other when it comes to exams or when they are doing seatwork and are asked to work out answers for themselves. She wants the students to gain confidence at the computer, to enjoy their work and not think it a solitary thing.

She can tell from listening to the talk going on at the computers that the students are always totally engrossed when they are using them, but she knows that there are other students in the class who are easily distracted by them. She worries about this aspect of computer use but feels that those who are easily distracted would "find something else to distract them" if the computers were not there.

Because computer use is a privilege in the classroom she has been able to motivate some students to complete their regular classroom work: "If I have kids who are not finishing their assignments . . . they just have to skip their turns until they are caught up-to-date. That inspires them to make sure they get their work done."

She finds that it is sometimes hard to maintain effective control when she is called away to help students at the computer. She feels that students should be able to pick up how to use software from the instructions supplied but that they tend not to read these, and depend on her instead. Her computer use journal, for example, noted quite a few "interruptions". She did say that students should be able to select software for themselves according to interest, help each other with problems, and monitor their own progress. The more they can do this, the less she has to monitor work at the computer stations. She welcomes software that takes on this monitoring activity, like managed mathematics programs. Parent volunteers come in periodically to help students on the computer and this takes off some of the pressure.

2.3.4 The Curriculum. The computer literacy work is like another subject, an "extra" Miss Somerset called it: something important but without an "official" place in the curriculum. She feels that the work of the curriculum has to be given priority in the meantime.

She has made some links to the main curriculum through the math drills and through word-processing activities, and she can see links between art work and designing pictures on the Macintosh, and between graphing and low-resolution graphics on the Apple. She said graphing co-ordinates is part of the Grade 3 curriculum and "MacPaint" is part of fine art; students are discovering ideas about symmetry.

She regards her work on computers as an extension of social and environmental studies work. Rather than do additional units in social and environmental studies, she has the students use the computer: "With the environmental studies I have covered the units they have in there. I think they expect us to go on to do other units. I'm using computers as my extra units. They are learning a lot about electricity and that sort of thing."

2.3.5 The System. Miss Somerset feels that she has been well supported by the principal. She does not think she should have time to pursue her computer interests in the school but she appreciates arrangements in the school that have helped her do her projects. She does feel, however, that it is difficult to accumulate the data requested by the board.

COMPUTER AWARENESS IN A JUNIOR FRENCH IMMERSION CLASS:
BATHURST PUBLIC SCHOOL

1.0 SETTING

1.1 The School

Bathurst is a K-6 school in the outer suburbs of a city. About half of the 650 students are in half-time French immersion. The school has five Apple IIe computers and a Macintosh. In 1983, a proposal for a pilot project was submitted to the board and the school was given an Apple IIe bilingual computer and a printer. Since then the Home and School Association have purchased a second Apple IIe system, a third came from the board under their one-per-school policy, and a further two were received from the board as part of the 1984-85 pilot project. The Macintosh, which was also received at the beginning of the 1984-85 school year, is used in the office and by staff.

The pilot project proposals were submitted on the initiative of one teacher, Mr. Barker, who has since left. These proposals were put together by the principal, Mr. Barker, and a group of ten interested teachers. It is now the principal who supports and sustains the projects.

Four of the computers, one of which is portable, are set up as a lab in the library. Until spring 1985, the fifth Apple IIe computer was permanently in the Grade 6 classroom but it is now being used more widely around the school. Mr. Franklin, the principal, said that staff had been slow to get involved with computers but, with the arrival of an older, female teacher-librarian who was also given the responsibilities of computer co-ordinator, the perception that computers are for young people who are technically oriented has gradually changed.

Mr. Franklin wanted every student in the school to feel comfortable using the computer by January 1985. For the 1984-85 school year he established explicit objectives for computer use, directed mainly at computer awareness. No direct pressure has been exerted on teachers to make them address these objectives but Mr. Franklin feels that he has been outspoken in stating his goals. He also wants teachers to become involved in assessing software. Although five teachers took in-service courses in 1983-84, he feels rather disappointed by the teachers' response so far.

Parent support has been strong and the school has been able to extensively use parent volunteers, although Mr. Franklin has some concerns about over-reliance on parent volunteers. He is also concerned about the quality of available software and the use of computers for classroom administration (for example, using powerful statistics in relation to student marks). Accountability is another concern: does the teacher know what the student is doing on the computer? Are the students genuinely in difficulty, trying to crash the program, or deliberately feeding in errors? How can the teacher know unless the students are being closely monitored?

In the near future, Mr. Franklin would like to install another seven computer systems to increase the size of the lab and to initiate programming in LOGO and BASIC to complement the drill and practice work that is now used. In the long run he would like to see a full-time computer instructor in the school.

1.2 Teacher Biography

Mr. Heiburg, a teacher with eight years experience, teaches in the Grade 6 French immersion program. He teaches in French and has one class during the morning and another during the afternoon. He first became interested in computers at university where he took a course in COBOL. Since then he has maintained his interest and, during his B.Ed. year, took a computers in education course. His present interest in classroom computer use was sparked by contact with a colleague, Mr. Barker, who initiated the school's pilot project and taught subjects in English to Mr. Heiburg's students. Although Mr. Heiburg was not closely involved with planning the pilot project, he began to use the computer himself in his immersion classes at the time of the pilot project's inception.

Last year he organized computer use through a merit schedule. The students who were the keenest or who, in his view, most warranted access were allowed to use the computer. After that it was a random schedule: two students per computer per hour. The computer was kept outside the room, in the hallway, on a trolley because the classroom was not equipped with sufficient electrical outlets for the computer.

This year the computer is set up in the classroom, on a table, along the back wall of the room. It is slightly isolated from the rest of the classroom furniture by a table placed behind it, which acts as a barrier. Access is still determined by rota and Mr. Heiburg tries to ensure relatively equal access provided students are up to date with their class work. The rota is flexible enough to permit spur of the moment changes.

1.3 Equipment

Mr. Heiburg's class uses an Apple IIe with a double disk drive, a green and a colour monitor, and an Apple printer. The colour monitor is set to one side of the computer, which is set up against the back wall on a table with wheels so that it is portable. The room is large enough to accommodate it easily. The computer system was in his room all day until just recently. Now he only has it for the first two periods in the morning although he would prefer it to be there all the time.

1.4 Software Used

In his computer use journal, Mr. Heiburg reported using French verb and noun drills, "Bank Street Writer", "Crossword Magic", "Print Shop", "LOGO". These were also the programs we saw in use when we visited his classroom.

2.0 COMPUTERS IN ACTION

2.1 How the Teacher Is Using Computers

We asked Mr. Heiburg to describe how he initially introduced his Grade 6 class to the computer: "I had the class gather round; I had them on tables in a tier fashion so everyone could have a look. We went through our introductory program and then I had them write a test." This took two or three sessions. Following this introduction, the students worked in teams on an introductory program and, after that, began word processing. They initially used "Apple Writer" but found it rather difficult, as Mr. Heiburg explained: "Unfortunately I went for the Apple IIe program first. I should have gone to the 'Bank Street' version first. 'Apple Writer' is not a menu program; it is a command program. It can run away with you, whereas with 'Bank Street' you are always in control. All of the class became literate in 'Bank Street'." The purpose of this work was to introduce the students to the computer.

Mr. Heiburg operates a rota system for using the computer. Students work in random pairs on the computer in the morning up until recess. When the computer was in his room full-time, a second pair would sometimes work after recess. Access to the computer beyond the random rota, or during recess or after school, is based on merit, using the computer as a privilege. If a student is not doing well at regular classroom work, then he or she will not be allowed to use the computer. The classroom work has to be finished because the work that is formally evaluated comes first. The software the students use is teacher-selected.

We visited Mr. Heiburg's class to see what the students were doing on the computer and videotaped their activities. The first pair of students we observed, Julie and John, were using "Crossword Magic", a utility program, to generate a vocabulary crossword for Grade 3 core French students who had watched a film on Glen Loates. Mr. Heiburg asked Julie and John to watch the movie and pick out words for the Grade 3 students to work on. He then checked the words and the students began to prepare the crossword. Mr. Heiburg felt that the crossword format would be interesting for the Grade 3 class and also easier for him to correct. The prime purpose of the exercise for his Grade 6 students was to familiarize them with the software.

Instead of preparing written clues, Julie and John were instructed to write down the words they had selected but omit a number of letters because written clues would be too difficult for the Grade 3 class to understand. They nevertheless began to make up written clues. Mr. Heiburg came over almost immediately and reiterated his instructions. The point at which he came over to help coincided with a break in the lesson.

When the students work in pairs at the computer they are supposed to take turns operating the keyboard, but mostly Julie used the keyboard while John contributed ideas, despite the fact that they were reminded to share. Mr. Heiburg said that he tries to ensure that dominating students share the keyboard with their partners. He said he can "smell it" when they are not sharing or when they are in difficulty with the program. This monitoring is instinctive: it depends on who is on the computer. "I pick up key responses. If I hear a dead silence, or they are gazing or shaking their heads, there's a clue there somewhere. I'll sidetrack the class so I can go over to the computer. It doesn't happen all that often. Any new program requires my attention. If the software is good there won't be a problem."

Mr. Heiburg also mentioned using those students who are already computer literate, because they have a computer at home, to assist students in difficulty at the computer. Julie and John, for example, were unable to print the crossword because they did not know how to interpret the print menu, which, in fact, did not need changing. John went to fetch Mr. Heiburg who was busy playing a language game with the rest of the class. Another student, Erik, noticed that there was a problem, came over, and told them that all they had to do was push "return" and the printer would work. Meanwhile Mr. Heiburg quickly ended the game by asking two or three easy questions. Before he could get to the back, however, Erik had solved the problem and the printer was running. Mr. Heiburg came over, saw that things were under control, and went back to the rest of the class.

We asked John and Julie what they thought they were learning. They said they were learning vocabulary through having to write clues for the words although this is not, in fact, what they were doing. John said that it helped with vocabulary and math skills and it "tests your quickness". We also asked them how they liked working together. At this all of the class laughed. Mr. Heiburg later explained that there is a hierarchy in the class which the students are careful to observe. As a consequence, Julie and John would not normally work together. They also told us that they would normally call on Daniel not Erik for help when they were in trouble. Mr. Heiburg noted that some students who are computer literate or who can supply good software but who are not popular and occupy a low place in the classroom hierarchy can move up a small way due to their computer skills. At the same time, some students would not normally be asked for assistance because of this hierarchy.

After recess, Erik and Daniel worked together with LOGO although Mr. Heiburg does not see LOGO fitting into his program very easily.

> It doesn't tie in with my class routine. If it's an art class, yes. It's a step towards BASIC, towards programming ability, but it definitely has its limits. Kids who are doing programming from Grade 1 would be beyond LOGO by Grade 6. They should be into BASIC. As far as math goes, there are programs in the school much more closely adapted to the requirements of the Grade 6 program.

LOGO is not central to the computer activities nor has it been stressed, yet Mr. Heiburg is prepared to let the students work on it if they wish: "They didn't have any contact with LOGO last year and I haven't encouraged it this year. I have asked a number of kids to become familiar with it and teach it to the rest of the class. They will have peer tutored each other in LOGO by the end of the year."

Erik, who was working on LOGO, told us that it was a "very easy language and uses simple English terms, and if you commit an error it doesn't say 'syntax error'." By referring to the

LOGO manual, which was written in French, Erik and Daniel created a small program to make a geometric design. They then created another program to produce the letter "M". Meanwhile the rest of the class was working on a science lesson with Mr. Heiburg.

Mr. Heiburg feels that some teachers might not be comfortable using the computer in the way he does: "Your attention is bi-sected, tri-sected, and the class has to work with a certain level of freedom. There is very little control on the class. If I had to run as highly structured a class as some teachers run, it would be very difficult to run this type of program."

2.2 What the Teacher Is Trying to Accomplish

Mr. Heiburg feels that it is important to prepare his students for computer use at high school and in society. He said that he got involved with the pilot project because he "could see the day when the kids would be using it; everyone would have one. I was particularly keen on getting my class ahead of everyone else's on the computer. They have a computer lab where they are now [middle school] and they were already quite literate in a variety of programs."

Mr. Heiburg regards the students' computer work as a subject in itself that should be reflected by a grade on their report cards. This mark would be a computer literacy mark and would grade progress and effort. No test would be involved; the grade would be based on the teacher's subjective observation, although the uniformity would be weak, he thought. Although he admitted that he is able to spend very little time with students at the computer, Mr. Heiburg feels that he does have enough contact with them to be able to give them a grade.

The students' work at the computer is not integral to French immersion but to computers as a subject. In Mr. Heiburg's own words, "It is as individual and remote from work being done in the classroom as if the kids were building an engine", yet many students work hard at the computer and Mr. Heiburg is seeking a way to recognize this effort even if the student does not succeed in mastering the computer work. He also feels that official recognition of computer-based work would generate a greater interest from the parents and possibly more in-class time for computers. "I feel that eventually, ten years down the road, computer literacy and comfort with the computer will take, if not high priority, at least a strong priority in evaluating a child's ability, in determining his or her future." He had asked the principal to add computer literacy to the report card but his request was refused.

Mr Heiburg described the aim of his computer literacy program as making students comfortable with the computer, so that they know the commands and can refer to the menu or support documentation if they run into problems. Beyond this, they should be able to organize their thoughts more accurately and to work with words more readily. He wants all of his students to become "literate" with "Bank Street Writer" as he considers word processing an integral part of literacy: it helps them write more effectively and they also become familiar with the process itself. He also sees drill programs in mathematics or spelling drills as providing remediation.

Mr. Heiburg thinks that the computer is unique because it can give interpretive feed-back. He used the example of word processing to illustrate what he means: if a child uses certain words over and over again, those words can be found and replaced with synonyms. Teacher input is at a very low level: once the child is "plugged" into an appropriate program, the program and the child interact. The teacher is only involved at the end in marking the work.

Mr. Heiburg regards his role in the computer work as mostly a matter of management, as opposed to interpersonal relations. By and large he feels that the computer manages itself, leaving him free to carry on the main work of the class. Any extra management effort is compensated by the time saved when the computer is used for keeping marks and classroom administration, about which he is very enthusiastic.

2.3 Factors That Influence Computer Use

2.3.1 Equipment/Software. Although "Apple Writer" comes in a French version, Mr. Heiburg favours "Bank Street Writer", which is in English only, because it is menu, not command, driven. He likes software that he can use to produce his teaching materials, like utilities for constructing crossword puzzles and test questionnaires. He does not find getting to know the software a problem: "It doesn't take genius to get to know the software. It just takes a little bit of time: plug the software in and just watch it. Just read a little bit of the text as well." He finds previewing software easier than previewing other materials but also has students evaluate software as he finds that they can decide for themselves whether it is appropriate or boring.

He finds the range of computer materials exciting: "I can hardly wait to get my hands on a new piece of software. The people who are making it up have a broader attack . . . than the people working on paper." He says he gets his ideas for using the computer from the software itself. Good software is interesting and also accessible, "user friendly". He feels, for example, that the LOGO literature is "friendly but the program on the screen is not all that nice." He would not rate it among the easiest programs to use and would not recommend buying it. "LOGO is not all that friendly; it will give you a blank statement, 'Well, I don't do this and I don't do that'." He thinks, however, that careful preparation can get around program defects like poor feedback.

Mr. Heiburg does not see that seatwork and working on the computer can be easily related. He finds that present programs that try to combine the two are "too young" for his students. He would rather they generate their own hard copy, writing a narrative or constructing crosswords or graphics.

Mr. Heiburg does find that extra preparation time is required in order to use the computer as he does, but he does not want a computer lab to be the only access he has to a computer. He wants to have one in his room because he feels that it is important for the students to know it is there: "It has to be part of the furniture." He would like to have a koala pad and a light pen because he feels that the system he has is not complete without this additional equipment, and would also like a modem.

2.3.2 Teacher Preparedness. Mr. Heiburg meets regularly with the principal and another teacher concerning the use of computers in the school. He says it is easy to fall behind because what is available is changing rapidly. He has not yet used the computer for graphics work, and he is concerned that knowing how to use "Bank Street Writer" is not enough. He feels he ought to also know "Magic Window" and "Word Star", and so eventually should his students. Some of Mr. Heiburg's students have, however, shown other teachers how to use "Bank Street Writer".

He feels that he is having to figure out how to proceed pretty much on his own but did say that having access to a computer had stimulated his interest in learning how to use one. He did spend a professional development day at the board going over software, which he found very useful, and hopes that the computer consultant will be able to visit his school to provide advice.

2.3.3 Students. Mr. Heiburg noted that last year's class was able to handle "Apple Writer" but this year's class could not, and he had had to move to utility programs and drill programs as well as "Bank Street Writer". The students' typing ability does not appear to pose any problems. He does not feel that students have to be proficient typists: "Two fingers is fast enough for what has to be done in word processing."

He is worried that students from other classes who come to use his computers may abuse his equipment and ruin the software. Only because his class is easy to control is he able to use the computer as he does. With more difficult students he feels that he would have to drastically change the way he uses it. His use would have to be much more structured. He would tend, for example, to stress drills rather than word processing and programming.

He sees no problem in the way pairs of students work together. Working in pairs is desirable because students motivate each other. He assumes that time at the keyboard will be shared even if one student dominates another because the stronger student "will give in". He also thinks that students working with each other will automatically blend their attributes.

He has found the boys to be "keenest overall". The more able students are most keen to explore new programs although he has found less able students eager to use the computer because it is a "friendly medium". He thinks that low status students could significantly enhance their standing in class through acquisition of computer expertise.

He looks favourably on students who are interested in probing the boundaries of the software -- finding out what is behind the program, even listing it. Getting to know the software is part of what he takes computer literacy to be.

2.3.4 The Curriculum. Mr. Heiburg sees his work with computers as forming a separate subject that he feels ought to be given a place on the report card. His stress is on computer literacy -- being able to use a variety of types of programs. Work on the computers is seen as standing alone, rather than being related to seatwork that the rest of the class is doing, although he does see some of the computer activities as loosely linked to on-going classroom work. He feels that the programs he now has, however, do not really allow him to integrate the computer with his French immersion work. The computer programs do not conform to what he has to teach in grammar and composition. He feels that he needs a fully integrated set of materials and many more machines if he is to try and integrate the two subjects.

2.3.5 The System. Mr. Heiburg is glad that he was able to get a computer through the pilot project because it has stimulated his interest. He did suggest that he had to look to his own devices to find ways of using the computer in his classroom. He thinks that access to computers confers an important benefit on the students he teaches and he feels their interests would be served if they were able to increase their access during the day. He is hoping that the system will make provision for this.

He wants to maintain the control over the computer he does have. He sees a benefit in having the computer in the room all the time as part of the furniture. He does feel, however, that the school ought to have a computer resource person to help teachers locate software and to show teachers how to use the computer as a classroom and administrative tool. He thinks that more input from the system is needed to help him learn how to use the computer more effectively, although he also feels he has done well in developing the students' computer literacy, especially with word processing.

He has offered to help other teachers, but this has not led to much activity. They have been more interested in his administrative uses of the computer than in the classroom uses. The extra time he has to put in is rather a burden because it takes time away from home. He has nevertheless been glad to do it because of the benefit it confers on his class.

COMPUTER AWARENESS IN A SENIOR PUBLIC SCHOOL: MARLBOROUGH SENIOR PUBLIC SCHOOL

1.0 SETTING

1.1 The School

Marlborough is a dual track English-French senior public school in the suburbs of a large city. It has a student population of 630 students and 33 teachers. The school is well-equipped with computers. In addition to a distributed Corvus network of ten Apple IIe bilingual computers -- the school's pilot project -- it owns three Apple II+, one Sinclair ZX81, and one Altair 680B.

The pilot project began in 1983 but, a few years prior to this, Mr. Mitchell, a Grade 7 science teacher with eighteen years experience and a strong interest in computers, began to introduce students to the computer by bringing two of his own into the school. His principal, Mr. Wain, responded to Mr. Mitchell's initiative by offering him slots in his timetable to use the computers for remediation and enrichment programs if he would raise the money for the school to purchase a computer. Mr. Mitchell raised enough money to purchase two Apple II+ computers with printers and accessories. At the same time, the school received another Apple II+ from the board through its one-per-school policy. At the beginning of the 1982-83 school year these three new computers were set up as a small lab called "The Apple Bin" and Mr. Mitchell took his two computers home.

In addition to the remedial and enrichment programs, Mr. Mitchell started a computer club, and undertook a school-wide "computer awareness and literacy" program.

> I tucked my Apple under one arm and my monitor under the other and went from class to class teaching computer awareness; dealing with the history of it, how a computer works, what it can do for you, what it can't do for you, if you are going to buy one how do you go about doing it. Nothing really though in terms of programming because the emphasis at this point was, and it still is, strictly applications and classroom use.

In these early days most children in the school were introduced to the computer through this awareness program and some students, mainly in Grade 8, had some "hands-on" experience that involved doing two or three lessons in LOGO and a lesson on BASIC in the Apple Bin.

When the call for pilot project proposals came out in early 1983, Mr. Mitchell applied for a distributed lab (computers placed in classrooms with a central hard disk source of programs). He was awarded ten Apple IIe's and he installed the system himself during the summer of 1983. Other teachers were then invited to make their own proposals to the principal for one of these computers. Mr. Wain decided where the computers should go. He tried to ensure that each area of the school, including the adjoining junior public school, received a computer. Mr. Mitchell undertook the responsibilities of system manager, for which he was allocated half a timetable. He continued to teach science for the other half. This arrangement extended into 1984-85.

In 1984-85 the school was allocated three new computers by the board: one Apple IIe, one Apple IIc, and a Macintosh. The IIc and Macintosh are in Mr. Mitchell's room, although the Macintosh is also used elsewhere in the school, including the office. The new Apple IIe has been added to the distributed lab system, making a total of fourteen computers in the network: nine at Marlborough and five at the adjoining school.

None of the school's budget is being spent on the computer program; all of the hardware is board funded. However, an average of $300-400 per year from student council funds or the school's dairy bar proceeds are spent on peripherals, such as a modem and joysticks.

Mr. Mitchell sees the benefit of the distributed lab as the greater staff and student involvement it permits: "You get more people right away, yet get teachers involved instead of just one person in his little lab doing his thing. I have fourteen teachers involved and there's a lot more hands-on experience". Security is, however, a problem -- both the security of the machines and the system itself since it is possible to access the hard disk system from the classroom computer and break into the system manager files. Over-ambitious students have twice disrupted the system. It takes many hours of Mr. Mitchell's time to restore the files and programs. In the fall of 1984, the school was hit in an electrical storm that destroyed all the programs and files stored in the hard disk system. This too took many hours to restore and, as a consequence, the distributed lab system did not get back into operation until early in 1985.

In addition to the distributed lab, Mr. Mitchell would also like to see at least one computer in the library on a permanent basis to teach the students how to use computerized card catalogues and on-line data bases for research. He also thinks the office should have a computer for administrative use.

Mr. Mitchell is an instructor of the Ontario Ministry of Education's computers in education course at Ottawa University. The other teachers have varying degrees of expertise but most are new to the computer. In the fall of 1983, teachers who were going to use computers in their classrooms spent a professional activities day with Mr. Mitchell learning how to use the system. They have since been using their computers for a variety of purposes: LOGO for problem solving; drill in mathematics; simulations. In one class, students' behaviour was a problem that forced the teacher to use the computer only at lunch time and after school. Another teacher found that the students became bored by simulations but he did do "awareness" activities. One teacher tried word processing but there are a number of difficulties associated with using the hard disk system for this. The printer for the system is not in the classroom but in the Apple Bin; one of the commands on the main menu wipes out the program and all of the students' files. Although Mr. Mitchell arranged for the files to be saved on floppy disks, the program itself can still be erased. As a result, "Bank Street Writer" and "Apple Writer" tend to be used instead for word processing in the classroom.

Mr. Mitchell teaches science but, for a number of reasons, he has not used the two computers in his room for this purpose: he has not found software that would enable him to integrate computer activity with the science program; he does not have enough time to do awareness activity in the science periods; and he feels that his class this year is not sufficiently attentive to permit a concurrent activity in the classroom. He is planning, however, to use his computers in his English classes for word processing as he has a printer in his room. The only snag is that he does not have a cord for hooking up his Apple IIc to the printer although he is hoping to obtain one soon.

According to Mr. Mitchell, the teachers have had to explore computers very much on their own, which has meant that "99% of them are using one specific program to do a specific job, and they use that because they haven't had the exposure, or nobody's said, 'Hey look, look at this it's so easy to use.'" They have found it time-consuming to find and preview software. In fact, much personal time has had to be invested by everyone. Mr. Mitchell himself has not found time to produce a computer awareness booklet he had planned. He has had to come in during weekends and holidays to work on the system. Some teachers have had to come in on weekends to go through programs. He thinks that the self-development has been interesting but that there should be a program for training teachers in computer use, and release time so that teachers can come together to work on common problems and find out information. There have been meetings for system managers like himself but he has not been able to attend any of them due to time conflicts.

Between them the teachers have explored a wide variety of software -- one of the initial objectives of the pilot project, since dropped. The special education teacher has found utility programs useful for generating crossword and word search puzzles. According to Mr. Mitchell, "a lot of teachers have been using those types of programs." In his work with the enrichment program and his computer club Mr. Mitchell has found that:

> at this age level LOGO is an interest at first, getting this little turtle whipping around the screen, and then it is a bore. The students say "Oh well, I've done that. What's the point?" so it dies quickly. The teachers try to move them into the programming aspects of it but they don't have the reasoning and logic to handle some of the specific, powerful commands that LOGO has available. . . . BASIC is a better tool because it is not as powerful and you have to go through a lot more structured steps to get to the same point.

In addition to LOGO and BASIC, teachers have also experimented with machine code and control technology.

Mr. Wain, the principal, credits Mr. Mitchell's enthusiasm as the driving force behind computer innovation in the school and is encouraged by staff and student response to Mr. Mitchell's initiative. As a result of the computers in the classrooms, he has noticed that staff are coming in early and staying late in order that students can use the computers. Mr.

Wain does, however, wonder about the educational objectives associated with computers and whether enough thought has been given to their role in school.

1.2 Teacher Biography

Mr. Owen is one of the teachers using the computer system. He has eighteen years teaching experience and is teaching Grade 8 English in the French immersion program. A couple of years ago, a number of computer professional development days sparked his interest in computers. "I knew they were coming," he told us, so in 1983-84 he took part I of the ministry's computers in education course. At the same time, he began to use a computer in his classroom. He was keen to experiment with classroom computer use and received one of the distributed lab machines for English language arts and math. One of his objectives was to experiment with word processing. This year he is attending a Macintosh workshop offered by the board one night a week. He still has the Apple IIe computer in his classroom but is not using it as much as he did last year.

1.3 Equipment

Mr. Owen has in his room an Apple IIe computer that is linked to the central processing unit but he also has a floppy disk drive. He has a green and a colour monitor. He does not have a printer, so if he wants to print he has to go to the Apple Bin, the computer lab. On occasion he borrows the Macintosh, but only for one period at a time.

1.4 Software Used

Mr. Owen does not have his own software for his class, but borrows programs from the computer lab on short-term loan. He usually borrows a few at a time and then changes them when the students have finished using them or have grown tired of them. In his computer use journal Mr. Owen reported using "Algebra 1,2,3" tutorials, "Bank Street Writer", "MacPaint", "Golf Classic" (at noon), and the koala pad.

2.0 COMPUTERS IN ACTION

2.1 How the Teacher Is Using the Computer

Originally Mr. Owen organized his English program to include computer awareness. He drew up a rota to ensure equal access to the machine and allowed the students to experiment with pieces of software he had selected. At the same time, he was taking the ministry course. He would arrive early at school each morning to work on the course assignments and he found that it was not long before those students who were keen to learn about the computer were joining him and helping him with his work. In this way, he felt that he was offering computer awareness to those who really wanted to learn and was progressing with these students beyond merely using software. A few of the students with computers at home knew a lot more about computers than he did and were able to help him and the other students working on his assignments. Mr. Owen felt that these early morning sessions were very successful but did not feel the same about the rota system during class time: "It didn't work too badly but I found it distracting. I found it distracting for me and I found it distracting for the other kids." He also found that students often needed help when they were using the computer and that interrupting his teaching to help them was another distraction, another frustration.

This year, instead of the rota, Mr. Owen has the students work on the computer whenever they can, more or less on their own, using a variety of software, including math games. He now regards having the computer in his classroom as having a "back-up": students can go and use it at the end of the lesson when they have finished their classwork. It is also available to them at lunch hours. As he explained, "The computer really isn't in the room. It is there, they use it. It's not like they want to be on it every second. It's as if students pull out something to read when their work is finished. They go over and do what they want on it and then they come back."

He selects the software and gives it to the students to try. He hopes that they will then be interested enough to continue using it but finds that their interest is not always sustained. He also encourages students to use the word processor for their work, particularly out of lesson time, but finds that many of them are too busy to come in at lunch, recess, or after school to use the computer for that purpose.

He has tried to teach the whole class about computers but does not believe that it is a subject you can teach that way; learning how to use a computer requires individual "hands-on" experience. He hopes that students will become proficient at using software on their own and, in that way, will be able to work their way through software with minimum supervision. One way to achieve this, he says, would be for students to be taught computer skills in a computer lab so that they could then use the classroom computer effectively.

Mr. Owen also taught an enrichment class of about twelve students for the 1984 fall term. The class was held in the computer lab. Here he found he was able to use the computer far more effectively for computer awareness. The students wrote a few programs in BASIC, used the koala pad, LOGO, and "Bank Street Writer". At the time of this study, he was looking after six students who have a spare one period a week, and again he is doing computer awareness with them. The lesson is held in his room but the Macintosh computer is brought in to supplement the one classroom computer.

As an example of a typical week's computer use, Mr. Owen reported that he had an algebra program available to students to work on when they had finished their regular class work. This program coincided with what he was teaching in math. He also had a word-processing program available for student use, although he said students tend not to use the computer for word processing. "MacPaint" was made available to a small group of students who had a spare to make title pages for speeches they were writing for a public-speaking competition. He used a cassette program to show the students how to use "MacPaint" and "MacWrite". The students frequently used "Golf Classic", a math game. Mr. Owen noted that it is one of the pieces of software that the students like and use frequently at noon hour. He used a koala pad in the computer room with the enrichment class to make a title page.

To enable him to work more effectively with the computer, Mr. Owen would like to see computers become an official school subject with a course outline and allocated time. This would clearly define exactly what students should be learning about computers and would also allow the teacher to monitor their progress in the subject: "This is where you start, this is how you continue. You can monitor progress. You can see where the kids are getting to, and you can give the kids tests, and you are aware of where they are having problems."

2.2 What the Teacher Is Trying to Accomplish

Mr. Owen has mixed feelings about classroom computer use. Although he originally thought that computers should be in the classroom, he is no longer so sure. He is torn between seeing the computer as a tool for instruction and seeing it as a subject in its own right. If it is to be used as a tool for instruction, then he feels that the students should be given a formal, organized introduction to computer use by a computer specialist in a computer lab so that they have the necessary skills to use the computer independently in the classroom as a tool during lesson time. If resources such as a computer specialist and a lab are not available, then guidelines to computer use should be issued to classroom teachers so that they can teach basic computer use skills. However, he is not sure that the classroom is where the computer should be. If computers are to be a subject, then they should be allocated time on the timetable, should be regulated by course outlines, and should be installed in a lab where their use can be maximized.

At present Mr. Owen has not resolved this dilemma. He continues to have a computer in his classroom but feels that his approach, particularly during the current year, has been rather "hit and miss". He feels that it is important that students learn how to use the computer in school because it is "the thing of the future". In his view, the only way to learn about computers is by using them, not being told about them: "It is not a subject that you can stand up, use charts, graphs and teach it. . . . You have to have the computer and you have to be on it." However, when only three students at the maximum can get on the computer at any one time, he only has the class for a forty minute period, and he is trying to push them hard in the math and language arts curricula, then using the computer in any systematic way and even ensuring that every student can confidently use the computer becomes difficult: "It is one more thing that the classroom teacher has to take on; there are only so many things you can do in a day."

2.3 Factors That Influence Computer Use

2.3.1 Equipment/Software.

Insufficient software was one of the problems Mr. Owen identified. When students have used the few pieces he can borrow at any one time, there is nothing else for them to do. He has tended to use software in his classroom rather than call up programs from the central hard disk system because the central system has so frequently been down. He has also found that the available software is not always appropriate. He does not use the math drill software with his students, for example, because "they are fairly bright kids . . . so there is no point in putting them on software for drills because most of those kids don't need that sort of thing."

He has found it difficult to find time to preview software and also finds that, with the exception of the math game software, he has to spend quite a bit of time helping students at the computer.

2.3.2 Teacher Preparedness. Mr. Owen feels he needs to know more about the scope, sequence and status of computer literacy in the curriculum and he needs access to models that illustrate how to teach the subject. In his view, "There has to be that course outline." He thinks the board workshops are an excellent introduction to the computer itself but would like to see more guidance and training for classroom teachers in how to use the computer with students. He wants to have a guide to presenting computers as a subject: "You start off here, and then you go there. And this is your next lesson and your next lesson." As he said, "You can't expect a classroom teacher to do formal lessons and teach the computer without some training." As a classroom teacher without formal guidance he said that, "You try to do the best you can without knowing exactly where you're heading." In his opinion, there should be a specialist teacher in the school whose job it would be to teach computers. Classroom teachers would play a supporting role. He also thinks that there should be more in-service opportunities for teachers to review software.

2.3.3 Students. Mr. Owen feels that the type of class he has influences the way in which he can use the computer in the classroom. He remembers with pleasure working with some students last year who were knowledgeable about the computer. These students were interested in the course work he was doing on the computer, would work with him on his assignments out of class time, offering their help and sharing the learning with him: "We had more fun with that sort of thing and they had fun that way too, I think. It was something for them to show the teacher how to do something for a change. I was very open with them." Mr. Owen saw this as a good opportunity for the students to learn about computers and they were also a great help to him.

> They really helped me out. One of them . . . was way above anything I could do. Anytime I ran into problems last year, I just got him to sit down with me and straighten it out. I don't have any kids this year who are at that level. . . . You have to guide them all the time. The other kids . . . would run through their own programs. . . . Most of the time I didn't have to help them at all.

Mr. Owen is not taking a computer course this year so these opportunities do not arise. Even so, he finds that this year's students are not as computer experienced as some of those last year and they cannot work as well on their own. There have also been attitude problems with this year's class to which he has had to pay close attention. He has shown students how to use certain programs but has found that their initial interest soon fades and "they get tired" of it; there does not seem to be the initiative to look for something else. New software is not readily available to them because it is stored in the computer lab and has to be requested through Mr. Owen. In addition, the number of extra-curricular activities in which his students are involved leaves them little time to use the computer out of class, for word processing their work, for example. As a consequence, computer use has to be built into his lessons.

Another difficulty of using the computer with a class that he describes as "very bright" is that the students want to work through material at their own pace, not necessarily going through all the processes that are designed into the software:

> They don't want to go through all the processes that the software takes them through. . . . They start jumping things because it is taking so long or they jump things they shouldn't have and, when they come to the end, they aren't sure where they have come from. So it's easier for me to do the work on the board because I can keep to the speed they want to go.

Monitoring the students' progress on the computer therefore becomes a problem.

The computer proved to be most useful in the enrichment class that he had in the fall. A small group of twelve students worked on LOGO and "Bank Street Writer" for about four months. Due to the size of the group, he was able to help the students on a one-to-one basis without having to worry about the rest of the class.

He finds that both boys and girls are interested in the computer but has noticed that more boys are using the computer, wanting to stay in at noon-hour to play games.

2.3.4 The Curriculum. Mr. Owen feels that there ought to be guidelines available for classroom teachers to follow if computer education is to be their responsibility. He compares the way computers are being introduced to how human sexuality was introduced a few years ago. This too was a new subject but one that came with a guideline and with resources -- familiar materials -- that teachers could use to teach the subject. Training in how to approach the subject was also provided.

He can see that computer awareness might be a task for the elementary school but is not sure about the details or about his role in teaching it. He thinks that a specialist teacher in a lab might be a more effective arrangement for teaching computer awareness, although he does see that the computer could be incorporated into the subjects he teaches, through word processing, or through utility programs for activities such as making title pages. Computer awareness in the classroom would thus come from the instructional uses of the computer rather than from a specific course in computing.

2.3.5. The System. Mr. Owen has found that being part of an immersion program and having to teach rotary classes have posed problems for him:

> You have the kids for only forty minutes. It's a very tight situation because they come in and you lose five minutes at the beginning and you lose five minutes at the end as they are getting ready to leave. . . . The kids just get on it and they just get used to it and get going on something and it's time for their next class. If you say "Well, if you've finished your work why don't you go out to the computer?", they'll say, "Well it's hardly worth it." And it is hardly worth it to start.

Not only is his time with each class short but Mr. Owen feels that he has to concentrate on the students' work . He is concerned about covering the curriculum set for them, and finds having students working on the computer distracting.

Another frustration for both him and his students is that there is only one computer. He reports that students do not want to work in groups of three. "It's like any of us, once we get there we want to use it, we want to get at the keyboard. You don't want to sit and watch somebody else, do you? You don't teach math that way, with a notebook and two kids with a pencil and they share the pencil and do every second question." For him, this is another argument in favour of taking the computer out of the classroom and putting it in a lab.

DRILL AND PRACTICE IN A SPECIAL EDUCATION PROGRAM:
WINSTON ELEMENTARY SCHOOL

1.0 SETTING

1.1 The School

Winston Elementary School is a K-5 school of 230 students and 13 teachers in the outer suburbs of a large city. The school's experience with computers began in 1982 when a parent lent a Commodore 64 to the school. It was placed in the library as a "resource" but was not widely used due to insufficient software. It did spark interest among some of the teachers, however. The next year, the school was awarded an Apple IIe under the board's one-per-school policy and, at the same time, the special education teacher, Mrs. Thomas, applied for and received an Apple IIe computer as part of the pilot project scheme. A rota was drawn up so that other teachers could use the computers in their classrooms if they so wished. There was no systematic plan, however, to give every student computer experience.

The principal, Mr. Leighton, said that Mrs. Thomas had approached him about obtaining a computer under the pilot project scheme and he had supported this initiative. He feels very encouraged by the way both students and other teachers have since responded. Two teachers are taking Ministry of Education courses and others participated in a professional activity day related to computers. He sees computers as very helpful for drill and practice and has equipped each classroom with old, second-hand, manual typewriters that he bought from the board so that students can practise their typing skills and thus be better prepared to use the computer when they get the opportunity.

Despite his enthusiasm for computers in the elementary school, Mr. Leighton is concerned that students may not be working at an appropriate level, or, if not carefully monitored, may be trying to "crash" programs for fun. He is also concerned that using the computers is a heavy extra burden on teachers' time. He feels that school time should be made available to teachers who are developing work on computers. He would like to see one computer in each classroom with a lab in the library and he hopes teachers in the school will continue to take initiatives in the computer field.

1.2 Teacher Biography

Mrs. Thomas is a special education teacher in the school. She works on a daily basis with students who have been identified and diagnosed as having learning difficulties, and on an occasional basis with students whom classroom teachers have identified as having problems with specific class work. The students may work individually or in groups. At the time of the study, for example, she was working with groups of Grade 1 and 2 children who were assessed at the beginning of the school year as needing extra help. There are approximately eight students in each group. She also works with Grade 1 students who were diagnosed at Christmas as having difficulties. There are also small groups of children who come to her from K-5 who have special needs. All these children come from their regular classroom for forty-minute periods.

She became interested in computers having seen the T.V. Ontario series on computers, "Bits and Bytes". It was this interest that motivated her to apply for the pilot project machine. As she explained to us, "Most of us are middle-aged and we have an excess of women so somebody had to get some idea of at least how to put a disk in!" She believes that, even if teachers themselves have no need for computers, they have a responsibility to their students to introduce them to a technology that will be a common feature of their lives. She has had little formal training and says, "I'm sort of having to feel my way so I can't really do anything that's severely complicated." In order to experiment with the software, preview programs, and program the teacher utilities, she goes into school on Saturday mornings to use the computers.

Part of Mrs. Thomas's responsibilities as special education resource unit teacher include administering the Canadian Test for Basic Skills (CTBS) to all the Grade 3 and 5 students. This is required by the local board. It is strictly a monitoring process and the students who do poorly are not usually remediated in any way. She has found that, although most of the students perform well on problem-solving questions, their computational skills are often weak. For her pilot project proposal she planned to remediate those students in Grade 3 with the lowest scores on the CTBS. In order to judge the effectiveness of the computer for this purpose, she divided the students into three groups and assigned each to a different treatment: paper and pencil, a Language Master machine, and the computer. She then planned to compare the results in the manner of a small research study.

1.3 Equipment

Mrs. Thomas is scheduled to have the Apple IIc three days a week. The machine may either be set up in her room or just outside the door. She also has occasional access to the Apple IIe, which also rotates around the school. As it turns out, she has generally been able to use the Apple IIe on the two days when she does not have the other computer. This means that she is rarely without a computer. She does not have a printer.

In her room Mrs. Thomas has a Language Master machine that she uses regularly with her students. Cards with drill exercises on them are fed through the machine and then the answers are spoken by an audio tape to orally reinforce the right answers. The machine comes with commercially prepared cards but the teacher can also make her own and record her own voice speaking the answers on the audio tape, which Mrs. Thomas does.

1.4 Software Used

Software Mrs. Thomas reported using in her computer use journal included "Magic Spells", "The Learning Line", "Tic Tac Show", "SRA Math Lab".

2.0 COMPUTERS IN ACTION

2.1 How the Teacher Is Using Computers

The computer-based remediation that was the focus of the pilot project ran for a few weeks at the beginning of the 1983-84 school year. A sixty-minute period was set aside for this each day. The eighteen students with the lowest scores on CTBS were given a pre-test and then remediated through one of three treatments: paper and pencil, the Language Master, and the computer. Each student worked for ten to fifteen minutes a day on this remediation, using only one of the three available methods for a period of two weeks, when a post-test was administered. The results surprised Mrs. Thomas: "I actually thought I would see quite a bit of a change in the children using the computer and, although they were on task a lot more, I didn't see as radical a change as I had expected. The Language Master seemed to be the best . . . there's sound with it, that could make the difference."

The students using the computer did, however, seem to be more highly motivated and more absorbed in the tasks they were performing. The other students were so eager to use the computer that, once the two-week period was over, she allowed the students to rotate through the three methods, although she felt that this blurred the effects of the different treatments.

The project was repeated at the beginning of 1984-85 with Grade 5 students, and again the computer did not seem to be any more effective than the Language Master. However, Mrs. Thomas says that there were so many variables for which she had not accounted that it is difficult to draw any conclusions.

Her lessons with the Grade 1 and 2 students who have been identified as having learning difficulties usually consist of whole group instruction followed by related activities that are done either individually or in pairs. For these activities, Mrs. Thomas uses written worksheets, the Language Master machine, and the computer. She has taken the new words from the Distar reading program she is using with these students, for example, and made drill cards for the Language Master, and put them into the computer using "Flash Speller". The students work for approximately ten minutes on these activities.

We asked Mrs. Thomas to record a sample of a week's computer activity and to comment on it for us in a computer use journal. Sometimes she had just one computer, but on two days she had two. One was used in the classroom and the second in the hallway. Grade 1 and 2 students worked on the Distar reading program using "Magic Spells". Pairs of students worked on this for about ten minutes before their turn was up. She remarked that the students enjoyed the activity and were highly motivated. Kindergarten and Grade 1 students used a drill program called "The Learning Line" with a joystick. The purpose was visual memory and vocabulary development.

Again she commented on the students' enjoyment. A drill on missing letters of the alphabet was used with K-2 students, and "SRA Mathematics Level B" with Grade 4 students who were sent from another class for extra drill and practice at the computer.

Students typically worked at these activities for ten to twenty minutes. Mrs. Thomas reported few management problems with these programs; most, she felt, were self-managed. She mentioned that younger children still need her help because they forget controls, and slower students do not understand instructions.

Mrs. Thomas finds that she can use students' enthusiasm for computer-based work to encourage them to do other work she expects them to do. She finds that the computer work stands pretty much on its own, as does work at other stations, but sometimes she finds using the computer frustrating because it is not always clear how to control it. If there is some basic mechanical problem like getting the program going, she may have to call the board's computer centre, Computer Place, and ask for advice or directions.

Mrs. Thomas also tries to provide computer access to other students whenever she can and hopes that the students will be able to find uses for their experience in the future in a world full of computers. She shares whatever she knows about computers with these students but also encourages them to explore its capabilities for themselves: "In fact what I often do is say 'Here's some LOGO, here's what I know. I can get you started, go along with the book.'" She says that the students are far better at learning these things for themselves than she is.

2.2 What the Teacher Is Trying to Accomplish

Children were pre-tested using the Canadian Test of Basic Skills and those who had low scores were divided into three groups, one of which worked at the computer. The intent of the project was to see if work on the computer made any difference to the post-test scores. Mrs. Thomas expected that the computer would be "highly motivational", because it gave rewards and reinforcement right away, and that it would create a higher "on-task" situation and, therefore, that the results would be far better than for the other treatments. Although students were keen to use the computer and seemed to be "on-task" more, paying greater attention to their work, no differences in their computational skills were detected.

Mrs. Thomas then wanted to see if differences could be detected at higher grade levels. She thought that age level and gender might be significant factors in effects of computer use. Again, she found it very difficult to control the variables but still thinks that the experiment could be done. Any future experiment would, she feels, have to be more controlled. She feels she would be able to do this research more effectively in the school than in a non-school setting.

The computer allows Mrs. Thomas to increase the amount of "one-to-one" work she does with students. Although it is no substitute for the teacher's support, she does see the computer as being able to take over the drill and practice aspect of her work: she called the computer "another arm". She has to provide the initial input, but once that is done "they are away to the races". The computer can patiently give large amounts of practice and positive feedback, something she would find difficult to give. Through interesting screen images, it provides repetition without frustration, which helps Mrs. Thomas deal with children who need considerable repetition.

Other important aspects of computer use for Mrs. Thomas include learning to take turns, time-on-task, motivation, the student's enjoyment, and the ease with which she can individualize programs. Although the computer did not prove more effective than the Language Master in terms of students' learning of arithmetical concepts, it is these other features of computer use that Mrs. Thomas values. She also finds the visual modality for math and language skills useful.

2.3 Factors That Influence Computer Use

2.3.1 Equipment/Software. Mrs. Thomas said that having the computer in the classroom is a good way for a teacher to become interested in using computers. She worries about control over programs, however: some programs seem difficult to interrupt and back up, for example, and it it not always easy to learn how to do this with the documentation supplied. Because of the type of program she runs and the way it is organized, she likes software that stands alone, that manages the learning.

Ordering software presents some problems. It is time-consuming to find suitable software, and program descriptions are frequently far from explicit. She told us about the time she ordered a program only to discover that, in order to use it, she had to have a master disk and a paddle stick. Some of the software uses upper case letters and she finds this a problem with primary students because it is accepted practice to teach children to read and write using lower case letters. She sees a need for programs that can meet the specific needs of children with learning difficulties. She does not feel that programmers understand the problems these children have.

2.3.2 Teacher Preparedness. Mrs. Thomas emphasised that it took a lot of time for her to prepare herself to use computers -- "You can't teach an old dog new tricks," she said -- yet she feels that it is good to have something new and different to try. She initially took a board course in computers but finds that there is so much going on in the school year that it is hard to find time to learn more about the computer. "It just takes time. Reading the manual, playing with the thing; seeing how it works, and once it works seeing what happens. It's almost like having to go back and relearn."

She thinks there should be more in-service activity aimed at showing teachers how to use the computer to supplement their own exploration of the technology, which yields ideas slowly. She knows she can go to the board and look at software, but again it is yet another task that she has to accomplish. As she said, "I'm doing it on my own time."

She thinks that, once teachers see children using computers in the school, they might begin to think about using them in their own classrooms: children learn very quickly how to use the machines and their interest might spark teacher interest.

2.3.3 Students. Mrs. Thomas is concerned that students are "on-task" and finds that they generally are when working at the computer. She thinks they learn vocabulary better on the computer. She finds that once students are launched on drill and practice work they are more or less independent of her. The program carries the interaction load. Her biggest problem is that children forget how to use the software and she has to remind them. On the whole, she sees no difference between the demands computer use makes on her and other seatwork activity.

She described a few students who are "leary" of using the computer. One student even finds using the computer upsetting, but she is an exception. Generally the students are very keen and, Mrs. Thomas feels, quite capable of teaching themselves how to use this new technology through the documentation in a way she herself finds difficult to do.

"Even in our day and age", Mrs. Thomas feels that boys are more forward about using the computer, more demanding and less afraid to try new things. It is the boys who stay after school: "The girls just don't seem that interested."

2.3.4 The Curriculum. Most of Mrs. Thomas's time is used to support the regular curriculum, and the drill and practice work on the computer flows from the remedial needs of the children who come to her special education classroom from other classes. However, she would also like to see enriched, individualized programs for the brighter children.

2.3.5 The System. Mrs. Thomas appreciates the assistance she has received from the board, particularly the "hot line" for help she has established with board personnel but feels that the courses they offer are too sophisticated for most classroom teachers: teachers just want to know how to plug software in and run it she said.

She hopes that other teachers in the school will become interested in using computers but is concerned about the time commitment it takes to learn about software and how to use it. Her comments imply that some provision for release from other duties would be needed for her to develop her expertise in computer-based teaching.

COMPUTER ASSISTED LEARNING IN A JUNIOR CORE FRENCH PROGRAM: CROMPTON PUBLIC SCHOOL

1.0 SETTING

1.1 The School

Crompton Public School is a K-6 school of approximately 500 students, located in the suburbs of a large city. Since 1983 the school has had a bank of ten Apple II+ computers but its first experiment with computers was in 1981-82 using one Commodore PET with cassette tapes. This was replaced in 1982 with two Apple II+ computers, one from the board and one purchased by the Home and School Association. The school's vice-principal recalls a "horrendous meeting" during which he tried, successfully, to persuade parents that one expensive computer compatible with the board's was better than many cheap computers that could be obtained for the same price. The computer lab was applied for under the board's pilot project scheme for the purpose of investigating which of three possible computer configurations would be the most effective and efficient within a K-6 school: a central lab of ten in the library; a small lab of four in the library and three pairs of computers, one pair in each of the primary, junior, and specialist divisions; a small lab of five in the library with a floating lab of five that would rotate intact through all three divisions. It was hoped to expand this compliment of computers from ten to twenty for the 1984-85 school year and once again experiment with configurations but this was not possible. The school was given, however, an Apple IIc and a Macintosh to add to the bank of ten. This makes a total of thirteen computers in the school at the present time.

For the past two years the bank of computers has remained in the library as a lab of ten from September through to November. From December to June a core of four computers has been left in the library and the remaining six, with the Macintosh, Apple IIc, and the school's own Apple II+, have been distributed around the school. With the addition of the Apple IIC and the Macintosh this makes a total of nine floating computers. They are distributed in such a way that there are four on each of the two floors and one in the office. The Macintosh goes wherever it is requested on a lesson-by-lesson basis. At the beginning of the year, each teacher interested in having a computer in the classroom is invited to choose a slot on the timetable. The original scheme to keep the floating computers either as a mini-lab or in pairs has been dropped in favour of allowing teachers to book individual computers because it is possible to book two or even three computers at the same time.

Although the concept for the pilot project was designed by the school's vice-principal, Mr. Hopkins, with the collaboration of two keen teachers, staff interest has been high. By the end of the first year of the project, two-thirds of the staff had completed an eighteen-hour in-school training course and, out of the school's twenty classes, only one was not using the computers at all. In order to relieve the pressure on teachers to learn about the computers at the time of the lab's installation, parent volunteers were used, with the unintentional consequence that some teachers initially tended to "abdicate" their responsibility for their class during scheduled lab time. As the teachers and students became more proficient, however, the parent volunteer scheme was abandoned. Mr. Hopkins' approach to staff involvement in the pilot project has been to rely on a core of very interested teachers while both encouraging the others to experiment and providing the necessary training for those who wish to participate. He has also made a computer available for his staff to take home and practise during weekends and holidays.

Mr. Hopkins describes staff response to computers in the classroom as "positive but realistic": they are trying hard to integrate the new technology into their existing lessons and classroom routines. He is, however, concerned that computer software is not well integrated with the Ontario Ministry of Education guidelines, which puts the onus for integration onto the teacher. Since this is time-consuming, it is rarely achieved and computers and guidelines remain somewhat divorced.

Mr. Hopkins is proud of what he sees as his school's lead in the computer field, and delighted by the very positive response he has encountered from teachers, students, and the local community. He feels, however, that there is a price to be paid for being innovative; in this case, rapid developments in computer technology have meant that, in his opinion, the Apple II+ computer is already "antiquated" and much of the new, more sophisticated software is incompatible with his school's machinery.

1.2 Teacher Biography

Mrs. Eliot teaches core French to grades 4, 5, and 6 on a rotary system. She uses the computers with her two Grade 5 and two Grade 6 classes. She first became interested in the potential for using computers in second-language instruction when she used the Commodore PET in the library. Since there were a couple of French drill tapes available in the school, she arranged to help interested students at recess, lunch hour, and after school: as the students found the tape system so difficult to manage, Mrs. Eliot found it impossible for students to use the machine without her presence, which meant that it could not be used during lesson time.

Although she did not find the computer particularly useful at this stage, she was intrigued by what it might have to offer and eager to experiment with one under classroom conditions where access and supervision would be less of a problem. Since the establishment of the pilot project in 1983, she has had at least two, sometimes three, computers in her room for the first two periods of the day, a total of eighty minutes.

She has taken the in-school introductory course in computers but feels that she is mainly learning as she goes.

1.3 Equipment

The computers she uses are all Apple II+ with single disk drive and both green and colour monitors, bolted onto portable computer tables. She has no printer. In the near future she hopes to increase her complement of computers with the addition of the Apple IIc which has a printer attached.

1.4 Software Used

Mrs. Eliot reported using the "Magic Window" word-processing program, "Hangman", "Crossword Magic", a few drill programs, and a translation/graphics program designed by a student from the University of Ottawa who assisted in her classroom as a French monitor.

2.0 COMPUTERS IN ACTION

2.1 How the Teacher Is Using Computers

For the past few years, part of Mrs. Eliot's core French program in Grade 6 has consisted of lecture, a reading program in which the class is divided into five groups of five or six students, each reading a different French story. In any given week, lecture takes up two of each class's five forty-minute French lessons. In addition to reading the story, each student is responsible for completing two written exercises. Mrs. Eliot has found that the computers can be used most effectively in conjunction with this reading program, which is set up as follows:

group 1 - 40 minute period in library under supervision of librarian

group 2 - 20 minute period of silent reading and written work in classroom

group 3 - 20 minute period with the French assistant correcting exercises

group 4 - 20 minute period with Mrs. Eliot correcting exercises

group 5 - 20 minute period on the classroom computers

The students work in pairs on the computer and the groups rotate during the lesson. This means that approximately twelve students get time on the computer during any one period, a total of twenty-four students during each class's two lecture lessons per week. Occasionally, Mrs. Eliot will use this time to slot in individual students who particularly need to review vocabulary or structures for which she has computer programs.

Mrs. Eliot usually selects the software to be used. She has learned from experience that new software causes students' attention to wander greatly away from the lesson to the computers unless it is previewed as a class activity first. She gathers the students around a single computer and demonstrates any new piece of software that comes in. After this initial demonstration she ensures that a couple of students know how to operate the program confidently so if other students subsequently get into difficulty during their computer time they know that they can call on other students as well as the teacher. She feels this kind of peer tutoring to be a necessity in classroom computer use: the newness of the machine, the technical aspects of computer use, the fact that a number of children are working entirely separately from the rest of the class put a pressure on the teacher both to be aware of what is happening where the computers are concerned and to be available to help at a moment's notice. If she is in the middle of class instruction, it is not always possible to give the computer-using students the attention they need; being able to rely on other students reduces the pressure on her while preventing frustration on the students' part.

Although access in her Grade 6 classes is determined by the reading group schedule, there is a rota for her Grade 5 classes in order to ensure a degree of equality in use. However, students whom she feels would benefit from extra time on the computer, usually for remediation or enrichment, are slotted in where necessary. She explained that students' eagerness to use the computer made the issue of access an important one:

> You can end up in a situation where you can use it as an incentive to good behaviour or good work and a deterrent to the opposite. But I don't know whether you should use the computer in that way or not. If it is a learning tool and it is effectively teaching something to a child, should you take it away from them because that child hasn't done what they were supposed to do? It seems to defeat itself, especially when you're looking at things like review exercises. If the child isn't working and listening in class, do you punish that child by taking away from him the very tool that might get through the information that you've been trying to get through to him? That's the problem, how to handle that.

Mrs. Eliot admits that having the computers in her classroom has made a big difference in the way she teaches.

> When you teach without anything else, in the traditional way, they all come in, they all sit down and you start the class. And you go through it, you do some seatwork, play a game or whatever, and it's very simple and straightforward. But when you are forced into a group situation, you have to look at different ways of doing things. Sometimes you have to come in and teach right at the beginning, at other times you have something they can sit down and do while you work with those children you are putting on the computers. If you are doing something new with the children on the computers, they need your time, right then, at the beginning. So you work on planning, start more of a run-on kind of thing where you don't have just one lesson, you have activities, multiple activities or at the end of one class you might teach them and they might have follow-up seatwork they bring with them the next day and start at the beginning so you can work with the children who are going to be on the computer. So it sort of confuses the whole thing, changes it.

In addition to this, Mrs. Eliot has to plan the lesson and manage the class so that when students are at the computer she is either teaching "something that they can afford to miss" or must ensure that they "catch up afterwards". When asked if this made her job harder and whether she welcomed this change, she declared that there were times when she could do without "the extra hassle" but when everything is going well, when there are no disruptions and the lesson is flowing, then she enjoys having computers in the classroom. She was sure that it had got her "out of a rut" and "added a new dimension to the language class".

However, computers in the classroom have coincided with a deliberate attempt on her part to alter her style of teaching and classroom atmosphere.

> In the last two years I've switched the emphasis in the classroom deliberately. I used to put a lot of pressure on them [the students] and it certainly achieved results. They still have a lot of pressure but . . . there's some new research which came out on language learning a couple of years ago and one of the things it came up with was the difference between learning and assimilation. You can't assimilate language if you're nervous and wound up, you have to be relaxed. So I decided that we'd better get relaxed! So I've deliberately slowed myself down . . . which carries over to them and makes them more relaxed . . . . It's certainly working much better, and because it is a much more relaxed way of doing things, less challenging and less forcing . . . computers fit the change of atmosphere . . . . I feel very good about it.

Despite the fact that she has been using the computers in her classroom for nearly two years now, Mrs. Eliot still finds the transition from seatwork to computer, as students get up and move across the room, disruptive. The students still have a tendency to be distracted by the computers too.

When problems arise with the computer that Mrs. Eliot feels incapable of solving, she calls on Mr. Hopkins, the vice-principal and school computer co-ordinator. It is a relief to be able to count on his expertise but, in her opinion, requires an openness with which not all teachers feel comfortable because "calling on another teacher for help is something that never happens in the normal course of events".

2.2 What the Teacher Is Trying to Accomplish

Mrs. Eliot quite frankly describes her attempt to integrate computer use and core French as "an experiment". She was very keen to have the computers in her room at the pilot project's inception in 1983 but did not feel that she knew enough about the implications of classroom computer use to be able to specify realistic objectives to guide her practice. She said that she began such an experiment in order to find out for herself how computers can be used in French instruction rather than be told by someone else what to do.

Her "first priority" has always been the core French program, not the computer. She wants all students to use the computer, being very conscious of its potential to provide both remediation and enrichment. Using the computer for these purposes also allows her to adapt her instruction more accurately to her students: if she wants to instruct the class in a concept that the faster students have already grasped, she can arrange for them to do an enrichment activity using the computer while she teaches the concept at a slower pace to the rest of the class. If she wants to challenge the abilities of the class but knows that the slower learners will not be able to keep up, she can arrange for them to review and practise previously learned structures or vocabulary using the computer. As a consequence she feels that having the computers in the classroom has made her very conscious of the different ability levels within the class and that she is now better able to meet the needs of students at "the two ends": "I don't know that it allows for more individualization but it makes it easier in some respects. . . . It encourages you to do more individualization which I think you could still do without a computer, it's just that you probably wouldn't as often."

Mrs. Eliot's overall goal for computer use seems to be to stimulate interest in French, to "give the child an incentive to learn the language". At the same time, she is anxious that they perceive computer use as "part of their work and not just a joyride". She feels that classroom computer use has been a big success in this respect: "I find they're more willing to use the language and they're more willing to work out what things mean than they used to be."

During our interviews she frequently expressed dissatisfaction with the way in which she was able to use the computer to teach core French but such complaints tended to centre around the limited availability of suitable software, which relegates the computer to a very expensive drill and practice machine: "I do feel that a machine that complicated should do more than that: . . . $3,000 worth of hardware should do more for me than just drill the children."

Despite the success that Mrs. Eliot feels she has had using the computers, she still questions whether she, and other teachers, are doing the right thing: "I think we don't step back and say 'How useful is this? How is this going to help what the child is supposed to learn in Grade 1 or Grade 3, whatever.'"

2.3 Factors That Influence Computer Use

2.3.1 Equipment/Software. Lack of suitable software for core French was a frequent complaint. The problem seems to be that there is such a small market for this kind of software and Mrs. Eliot feels that software developers ignore it. Since the students' ability to speak and understand French is well below their cognitive level, they require software with very simple French or even English instructions but the program itself must be sufficiently difficult to challenge them. Software produced for the French-speaking market is far too difficult for these students. Mrs. Eliot is looking for software that will "teach the child, give the child an incentive to learn the language and give them practice at comprehension and practice at all the things they learn in the English language, teach them things they want to know about in French, on a simple level".

Mrs. Eliot feels that French language software tends to focus on vocabulary rather than grammatical structures, but does not find this to be particularly useful. She would like to see more software to teach grammatical structures, and more that would "use the language as a language rather than broken down into bits". She does feel that drill and practice is a potentially useful application of the computer in core French since "vocabulary acquisition can be monotonous but CAL gives it an extra element of interest and stimulates the students to learn and remember vocabulary". She would like to have a library of suitable software sufficient to provide "instant variety", both for remediation and enrichment.

Mrs. Eliot's information about software comes mainly from Mr. Hopkins. She has tried asking other French teachers but, due to the software limitations, finds that they are doing little other than drill and practice programs. She reads the manufacturer's catalogues and occasionally computer magazines but she finds that this is very time consuming and has learned from experience that many of these programs are not all that they are claimed to be. She has previewed some of the materials at the board's resource centre, has attended conferences where software has been displayed and demonstrated, and has even arranged for sales representatives to come into the school so that she can preview material prior to purchasing. She feels rather disappointed about what she has seen. Ideas about how to use the software are generally self-generated. Previewing does not appear to present a problem, but locating software she finds very time consuming. She feels that there is just not enough information about software available for the classroom teacher. She would like to see greater co-operation between software producers and teachers, suggesting that the industry consult teachers about what they need.

One limitation that she does not feel will be overcome for a long time is a suitable voice for the computer. Since she is teaching a subject that is mainly oral, she would like to see programs and hardware that would cater to this. At present, she feels that the computer has nothing to offer those students with weak phonic skills.

Computers in the classroom have required some physical re-arrangement of the furniture, removing a row of coat hooks to open up some space, for example, but she manages to fit three computers in reasonably comfortably. When the software includes beeps and other noise she wheels one computer into the hallway outside where there is an outlet so that the noise will not distract the rest of the class.

2.3.2 Teacher Preparedness. Although she has taken the in-school computer course, Mrs. Eliot is very much learning as she goes. She finds it a great relief to be able to call on Mr. Hopkins whenever necessary but says that even doing this requires a certain openness on her part. The other aspect of using computers that requires some openness, some adjustment, is accepting that students may know as much or more about computers than she does.

> At this grade level, there is nothing that these children can tell me about French. However, when it comes to the computer there may be a student in the class who could handle this a lot better than me. So this is a little change in role. Rather than the separation of the giver and the receiver, you've got a mixture of the two and you're working together. Often a student and I have sat down and worked it out between us. . . . This is more a co-operative effort than me saying, "No, this is not how you do it, you do it this way!"

She describes this role reversal as a "bonus" in the language classroom because "Normally, at this level of language learning, the gap between the students' knowledge and that of the teacher during all activities is far wider than that which exists in a normal class, or at least far more obvious to the student." The newness of the computer makes control of classroom knowledge a little more equal.

Another aspect of having the computers that she is learning to accept is the amount of control she feels she has over the classroom environment.

> If the kid presses the wrong button and blows his program when he is half way through it . . . it is no good saying "I'm doing this, you'll just have to sit there." You have got to do something. You have to, right at that time, cope with the fact that you have a whole classroom sitting there and you've got these one or two frustrated children sitting there with a blank screen, or a screen that won't save or something. You have to be adaptable.

Mrs. Eliot feels that teachers do not need a high level of computer expertise to incorporate computers into the classroom but, if the instruction and the software are to be adaptive to student needs, the teacher needs to know a little programming so that vocabulary, grammar, or graphics can be added to commercial software through the teacher utilities.

2.3.3 Students. The aspect of using computers that has proven to be the most rewarding for Mrs. Eliot is her students' attitude to French. Although she is reluctant to attribute this solely to the computers' presence, because of changes she has made in her teaching style, she has noticed a marked increase in students' enthusiasm:

> They still say, "Ugh, French!" but the attitude does not come past the door. It's something that everybody says, nobody likes French, everybody hates French, but it doesn't carry over into the classroom, whereas a few years ago it certainly did . . . . I find they're more willing to use the language and to work out what things mean than they used to be. . . . I feel very good about it.

Mrs. Eliot finds the students less apt to "fool around" when working on the computer, even those students who could normally be expected to be disruptive. Another somewhat surprising consequence of using the computer in French is that students' willingness to work on the more monotonous aspects of the language, such as drill and practice, has improved, even when the work is not computer based.

In Mrs. Eliot's experience, the students respond so well to the computer because it is so positive: it does not put red marks all over the child's work nor make obvious the child's mistakes.

> It's a lot less devastating for the child to work through the computer and not get the answers right than it is to spend hours doing this paper and then get all their spelling questions wrong. . . . And the fact that they can go back and get more success . . . and some of them keep getting a little better every time and they're thrilled about that. "I got 10 out of 50 last time, I got 15 out of 50 this time!" So they've got this positive reinforcement that they're getting better. And that's something that it's difficult for the teacher to do.

Although the students regarded the computer as a "game" at the beginning of the year and were extremely anxious to begin using it, they have gradually become more discriminating where software is concerned and prefer programs that challenge them, particularly those in a game format.

Although Mrs. Eliot has noticed some gender differences in computer use, she says that they tend to reflect differences apparent in the regular classroom: boys tend not to persevere with programs but like frequent change; they are more pushy but also more willing to experiment. Girls will more readily accept software or patterns of use determined by the teacher. All students, however, keep tabs on how often they and other students get to use the computer and do not hesitate to protest if they feel that there is inequality. They do not seem to understand that it is sometimes appropriate for certain students to spend more time on the computer, for enrichment, for example: "You get times where they say, 'I haven't been on for three weeks and so-and-so has been on twice during that time!' But so-and-so is getting one hundred percent in all his work!. . . You can't turn round and say, 'Look, he's doing fine and you're doing the pits!'

2.3.4 The Curriculum. Aside from the lack of correspondence between software and curriculum, Mrs. Eliot's major concern is integrating the computers with an essentially oral subject. She is also concerned that she and other teachers do not lose sight of the fact that their job is to teach French, not computers. "There are lots of things that I could use the computer for in the classroom and it would look great, and it would impress the parents . . . but it wouldn't be teaching the language. . . . It's only forty minutes a day and you can't afford a lot of time helping them to do something not related to the language."

2.3.5 The System. Mrs. Eliot would like to see more readily available information about software -- more than just a title -- as she feels that the classroom teacher cannot be expected to be an expert in computers or to have the time it takes to keep up-to-date with the market. She is very pleased to have the opportunity to participate in the pilot project and experiment with ways of her own to integrate the technology with her subject and classroom, but she feels that the experimental nature of the pilot project scheme has prevented the board from being as supportive as it might have been.

WORD PROCESSING IN AN INTERMEDIATE LANGUAGE ARTS PROGRAM: CAMBRIDGE MIDDLE SCHOOL

1.0 SETTING

1.1 The School

Cambridge Middle School is an open-plan school with a strong dual-track English/French program, located in a well-established suburb of a city. It has 733 students in grades 6 to 8, 37 teachers, and 7 computers. Mr. Banks, the principal, said that he had originally hoped to get a computer lab from the board for Cambridge but that had not happened. Of the seven computers currently there, five are located in a computer lab, and two others with printers -- both pilot project machines -- are in classrooms.

Computer use in the school began in 1982 when the librarian managed to obtain one of the first pilot project computers available from the board. This experiment with computer use only ran for a couple of months due to technical problems, but it spurred enough interest for the school to apply for a renewal of the project for 1983-84. The librarian, Mr. Dyer, approached a number of teachers he thought would be interested in drawing up pilot project proposals. The school was subsequently awarded one computer for the pilot project, one under the board's one-per-school policy, and a third was bought with funds left over from a highly successful but totally unrelated fund-raising event held at the school. Mr. Dyer, who began to undertake the responsibilities of computer co-ordinator for the school, aimed that every child in the school should have had "hands-on experience" by the end of the 1983-84 school year.

Two of the three teachers running pilot projects wished to re-apply for 1984-85, and another teacher, Mrs. Everett, who had not previously been involved, also wished to submit an application. For 1984-85 the school was awarded another two Apple IIe computers for the pilot project, an Apple IIc, and a Macintosh.

Now that every child has been on the computer, Mr. Dyer aims to develop the potential of the computer lab as a learning resource because he sees a lab as the most effective and efficient use of the computer in the school setting. Teachers can book the computers from the lab for use in their classrooms, but the open-plan concept makes moving the computers difficult: the school is multi-level and there are just too many stairs. The teachers therefore tend to book students into the computer lab, under the supervision of Mr. Dyer. Mr. Dyer describes the teachers' response, however, as cautious although interest continues to grow. A few teachers, including Mr. Dyer, have taken ministry courses, and twelve teachers participated in a recent in-school professional development workshop.

1.2 Teacher Biography

Mrs. Everett, who has been teaching for eleven years, describes herself as a "total novice" where the computer is concerned. She teaches language arts and math in English to three classes in grades 7 and 8. For the past three years she has been using Donald Graves's methodology of teaching writing in her language arts programs. She gently worked into it, "not feeling too confident", by asking students to keep journals. But now thinks that the methodology "works so well; I really enjoy it. I don't think I'll ever teach writing any other way." Graves's methodology stresses revision of students' writing, student conferencing, and publication of final drafts as important phases in the writing process.

Although she had absolutely no computer experience when she put together her pilot project application, she subsequently took a six-hour summer course in computers. Looking back to when she first applied for a computer, Mrs. Everett recalled writing objectives that were a lot less focused than those she has since adopted. They concerned using and evaluating language arts software, such as spelling drills. She reported that it was not until she actually began to use the computer in the classroom that she realized its potential in the writing process. At this point her pilot project objectives changed and she decided to try to incorporate computer use into Graves's methodology of writing.

She designed her new pilot project along the lines of a small research project to study the effects of computer use on the revision phase of the writing process. This study also grew out of her interest in linguistics, which she has has been studying for the past three years. This dual interest, in linguistics and the writing process, has become the focus of her experimentation in the use of computers in the language arts; it is a way for her to develop an understanding of the computer and its uses in the classroom.

1.3 Equipment

An Apple IIe and two disk drives are bolted to a table in her portable classroom. There is a green and a colour monitor, and an Apple printer. The table is in a back corner of the room, to the left of the teacher as she faces the class. The screen faces inwards to the side of the class.

When she drew up her original pilot project proposal, Mrs. Everett asked Mr. Dyer for advice as to which equipment she would need. She did not ask for a printer because she did not envisage the new direction her project would take, so she is currently using one on loan from the computer lab. She was advised to ask for two disk drives but has since found one to be sufficient for her present use.

1.4 Software Used

Originally, Mrs. Everett used spelling tutorials but she stopped using these as soon as the concept of her revision project was finalized and she began to use the computer for word processing. Now she only uses "Bank Street Writer" and its accompanying tutorial.

2.0 COMPUTERS IN ACTION

2.1 How the Teacher Is Using the Computer

Mrs. Everett's research project involves ten students of varying writing ability who volunteered to work with her to do some extra writing. These students submit all drafts of several stories, some of which are composed using pen and paper and others which are composed entirely on the computer. She plans to analyse and then compare both the process and the products of these two different methods of writing. She wants to "compare the types of revisions made on the word processor; not only the types but the number. There will be a holistic scoring of the papers so that the quality of the work will be taken into account". She wonders whether this will give her far more writing than she can analyse given the time available to her for her project but feels she can probably "pare it down to where I can cope". Although the project students submit all their drafts, only the final copy is marked.

The non-project students compose their stories at their seats using pen and paper. They then type the final draft using the word processor and print a good copy that they submit to be marked. All the students' work is marked about once every one or two months and all the students are encouraged to write about things that they care about, something that has meaning for them.

Mrs. Everett is using "Bank Street Writer" as the word processing program. She introduced all the students to "Bank Street Writer" using the tutorial program that comes with it. Nine of the ten project students also went to a workshop on "Bank Street Writer" with Mrs. Everett at the board office. In the initial stages of using the computer with the class, she found there were a few problems. She was saving students' writing on one disk only and one of the students accidentally erased the disk so she now uses a back-up disk and has the students print out their work regularly. Each pair in the group of ten has their own disk. Early on, if there was a mechanical problem or something she did not understand, Mrs. Everett said she had to leave the problem and check it out with Mr. Dyer or other teachers who were experienced, or try to solve the problem herself after school. The need to do this has now decreased.

As a rule, each student has a forty-minute turn on the computer. A schedule is prepared well in advance so that they know when their turns are coming up. Those students participating in her research project get about twice as much time on the computer as the rest of the class because they are composing their stories on the computer; the rest of the class only type in stories written with paper and pencil. If they wish, students can also go over to the computer lab. Mrs. Everett said that most of the time they take their writing with them, which increases their computer access. Some children also get special attention from the learning resources teacher there.

All students are involved in writing, all have access to the computer, but the group of ten have more access and are more familiar with word processing. Mrs. Everett felt that it would normally be unfair to concentrate on ten students in this way but the project made it necessary, and she said that all the students understood why things were set up as they were.

As part of the writing process, students confer with the teacher and with each other about their writing during writing periods. It is during this time that Mrs. Everett meets with the ten students in her project. Students have to feel comfortable in order that they can share with each other, Mrs. Everett said, so they tend to confer with their ability peers or with students with a similar sense of humour, for example. Some of the project students confer with students who are not in the project and are thus integrated with the rest of the class during writing periods.

The machine is constantly in use while the teacher is in the room so Mrs. Everett has had to work out some ground rules -- the printer must not be used during lesson time because of the noise it makes, for example. When the students need help they must not interrupt the class but wait for a pause in the teaching, try to work the problem out for themselves, or ask another student. Occasionally the printer is used during lesson time but students will make eye contact with the teacher to ask if they can print. Most of the time, Mrs. Everett said, the students are sensitive to what is happening in the rest of the class and do not disturb the flow of the lesson. Sometimes the student at the computer is asked to pay attention to certain points the teacher is making to the rest of the class but normally students at the computer are not interrupted.

On the day we visited Mrs. Everett's class, they were listening to each other deliver speeches they had prepared while those students scheduled to use the computer were taking their turns composing or typing their stories. One of the project students, Karen, was working on a story about having to make a speech in class. She had already been working on it for three periods. She used the computer with some facility and did not seem to be distracted by the noise from the rest of the class. She did not edit her work on the screen but waited for the printed copy. Mrs. Everett remarked that Karen does not always fully correct the copy she hands in: "She may forget."

Sally, a non-project student with an unspecified learning disability, was the next student on the computer. She was typing in a poem she had written that had an irregular line pattern, but she was using the space bar instead of the return key to paragraph. She set it up as she wanted it on the screen but was disappointed with her printout because it did not resemble her original in design. She thought that this was due to a fault in the printer. Mrs. Everett explained that Sally did not understand the concept of "wrap around". She did not press the return key to create each new line. Mrs. Everett felt that such a situation was not specific to the computer: "It's like teaching a math lesson. Probably one of the other kids will show her." If it were a common problem, she said, then a whole class lesson on the return key might be needed. Sally also had trouble using capital letters but she was patient about it. Mrs. Everett said that students, more so than adults, are used to struggling with things, meeting with difficulties, and not achieving rapid success. Mrs. Everett had not noticed any impatience on the part of students with word processing.

Instead of returning to her seat, Karen stayed at the computer to help Sally. Mrs. Everett thought that there would be students Karen would not be willing to help because of peer interaction. Similarly, there would have been students with whom Sally would not have been comfortable for the same reason. Mrs. Everett said that the students seek out help when they need it and sometimes she goes over to see how they are doing. She uses quiet moments in the class for this but will interrupt if the student needs help and there is no one else in the class who can help. Sometimes she asks the rest of the students to wait for a little while, which, she said, they accept.

Samuel, another project student, was scheduled next. He was writing a story about a haunted refrigerator. Mrs. Everett told us that he confers with students who understand his sense of humour and catch on to his puns, and likes to print out his story in double-spaced edit mode even though he has to hand in single spaced stories. He was moving his material around and said that he liked being able to correct any word in his text. He felt that being able to move things around easily helped him write. Samuel had learned a variety of functions through the use of the tutorial, the menu, and through mini-discussions for the group of ten at the beginning of the year.

The next student, Mark, had to remove passwords from his work. He was having difficulty with this and had to call on another student for help. Mrs. Everett did not want the students to have passwords since it meant that neither she nor the other students could access the work on disk, and it was not clear to her why Mark had put passwords on his work. Mark then began to work on his story, which his father had edited for him in pencil on the printed draft copy because Mrs. Everett had been away. Mark, however, thought that his work was easier to correct on the screen than on the printout.

2.2 What the Teacher Is Trying to Accomplish

Mrs. Everett stressed the need to help students become better writers. She wants to find out if word processing contributes to better writing. She feels that one of the advantages of word processing on the computer is being able to move material around. She has found, however, that some of the students are hesitant to do so, especially those who are not in the project and those who are not "as quick": "They are afraid they don't know how to do it." She thinks that access to the machine motivates the students and gives them a sense that "they're on their own," and they enjoy receiving printout: "They like to feel good about their writing; they like to see it; it looks terrific; it looks very professional. Even if there is an error you don't want to put your pencil on it because it looks so nice." Mrs. Everett also hopes that their "level of thinking" might be increased through their computer use.

Mrs. Everett has an open mind about what her research project might yield: "I have no preconceptions about what's going to come out of the research. I'm curious to see whether the revisions are going to be similar, different, increased, or decreased, or whether the children are going to be hampered by the computers.

Looking back, Mrs. Everett thinks that the students in her pilot project have had intensive feedback while the rest have increased their "hands-on" computer time. She feels she has learned more about how students revise their work. The students, she thinks, are glad to increase their knowledge of computers with a career in mind: "They are important in our lives." She has also learned that students respond to the computer in quite different and interesting ways. It seems that some students do not like writing with the computer.

2.3 Factors That Influence Computer Use

2.3.1 Equipment/Software. One computer is a limitation because there is not enough time to meet the needs of all the class. It would be difficult, however, to place many more machines in the portable classroom. The one computer in the classroom has had to be secured by bolting it to a table and bolt locks have had to be put on the door. Security remains a worry.

Mrs. Everett and her students have not found the "Bank Street Writer" manual much help but the tutorial program on disk has been helpful. Some students have had difficulty editing, which Mrs. Everett thinks might be eased with a different program. She is concerned about the delicacy of disks and has made sure that back-up disks are kept up-to-date. Noise from the printer is a difficulty and Mrs. Everett has asked students to print at times when they will not disturb the rest of the class. She would like to see other software for language arts and to see the research that supports the effectiveness of the software.

2.3.2 Teacher Preparedness. Mrs. Everett has attended a six-hour summer course on computers and a workshop on "Bank Street Writer", which she has also taught herself how to use through the tutorial supplied with the program. Getting to know how to use "Bank Street Writer" was time consuming, and being sure she really knew the program was a worry.

2.3.3 Students. At the beginning of the year, the students were excited by the computer and ground rules had to be set. They have been willing to co-operate and have enjoyed their experiences. Some students still ask for help, but the demands on the teacher have declined and the need for help has decreased as students have learned how to use the system and can help each other.

Some of her students have become very adept at using the computer and they help other students who are having difficulty. Mrs. Everett relies on these students to help her manage computer use. Students differ in their capacity to do word processing, Mrs. Everett said. Some who have not had extra access are doing just as well as those who have. Some of her "reluctant writers" have difficulty remembering how to edit, perhaps because they lack practice. She feels the program needs to be easier for them.

The students enjoy seeing their work neatly printed out; yet some also want to improve their handwriting. Slower students are willing to spend more time writing on the computer, which Mrs. Everett feels is a good thing. Better students are able to work well in either mode but if they do not edit well at their seat they do not edit well at the computer either. She feels that the computer provides students with something new -- it fits in with the times and the students enjoy working with it. Not all students find that it is the best way to do their best writing. Some feel that they could do better work and get better marks at their seat. For some, the computer seems to have been an obstacle and has led to inferior writing.

Mrs. Everett thinks that working in pairs is a positive way of organizing students as they can learn from each other. She takes the view that it is up to them to be patient and considerate with each other. She does not allow negative behaviour to disrupt the rest of the class, and she expects students to be responsible for solving their problems and getting benefit from their work. Some students, she feels, are not machine oriented and she can understand their difficulties with the computer. She said that, in a sense, working with the computer has helped them to get to know themselves better.

She encourages students to consult one another about their writing and when things get a bit noisy she intervenes. She remarked that "Not all the children are able to handle that kind of freedom, but I think that it is more of a benefit than not." Nonetheless, she does not see students being denied access as a punishment. They have to learn to get on with their work.

Students vary in their level of confidence in using the computer. Some are hesitant to make changes to text, for example. They want to be sure they are doing the right thing. The reluctant writers seem more hesitant, less willing to risk making a mistake. She has found that students are not generally as worried about making an error on the computer as they are on paper because "the computer doesn't penalize you, it doesn't scream at you. Now they do get frustrated sometimes when they don't read the instructions correctly and they get stuck. Then I'll interrupt my class".

She has noticed that boys tend to stay after school and work on the computer more often than girls but, other than that, has not noticed any gender differences. She has encouraged girls to take an interest and they have responded well.

2.3.4 The Curriculum. The project is fully integrated into Mrs. Everett's Grade 7 and 8 writing program. The work that the students are doing is what they would be doing during her lessons without the computer. The only difference is that some are able to compose stories at the computer and all are able, in varying degrees, to type their stories into the computer and obtain print-out.

Mrs. Everett has the extra task of analysing the handwritten and computer-composed scripts for revisions, as well as marking the work in the usual way, but this is part of her own research project rather than a process that she normally builds into her writing program.

2.3.5 The System. The pilot project has enabled Mrs. Everett to pursue her interest in writing and in computers. She reported that parents have been interested in what she is doing, especially as the computer is in the room during interviews. She also feels that there is interest at the board in the work she is doing and she is hoping to get support to write up the results of her project. The board has also provided some in-service support, although Mrs. Everett would welcome a visit from board computer personnel. She did say that it had taken considerable effort with short deadlines to present a proposal to the board, and she wonders if there is not too much paper work attached to these sorts of projects. She is also hoping that the board will circulate an index of software.

She indicated that she has received considerable help in getting started on her project from other staff members. The school computer co-ordinator, Mr. Dyer, has supported her efforts and she has been lent a school printer. Use of the school computer lab has enabled her to increase the access her students have had to a computer to do word processing.

TUTORIAL AND SIMULATION ACTIVITIES IN A GEOGRAPHY DEPARTMENT: ALBERT SECONDARY SCHOOL

1.0 SETTING

1.1 The School

Albert Secondary School is located in the suburbs of a city and caters to a largely middle-class population of approximately 1,600 students. The geography department is one of three departments in the school to receive pilot project computers from the board. The submission to the board stressed the importance of a problem-solving approach to geography and the value that computer-based simulations had in supporting this approach. The head of geography, who wrote the proposal, hoped that he could share his experience with others in the board.

Prior to receiving pilot project computers, the school used computers for data processing (TRS 80s and Apples) in computer studies and in technical studies. A software committee met periodically to appraise software and recommend purchases to the principal. With the advent of the pilot project, computer assisted learning (CAL) began in earnest in the school.

1.2 Teacher Biographies

Mr. Devon is head of geography. He has twenty-two years teaching experience, has been at Albert for eight years, and has had two years experience using computers in his classes. His use of computer simulations is an extension of his interest in geographical simulations. He became familiar with CAL through developments reported in a British geographical magazine. He ordered a book on computers that was listed in the magazine, and subsequently wrote to one of the authors for advice on where to obtain computer simulations. At that time, he shared a computer with the science department and, although there were scheduling problems, he learned about computers from the science head. Since then, he has obtained, appraised, and used a wide variety of geography simulations, mostly from the U.K. With a colleague he began to try out various programs including the Digital Huntington Project Simulation Material. He regularly looks through computing magazines to find out what is available in his subject area. He has rewritten teacher guides so that he can integrate the computer-based work with the geography curriculum. He has used computers with his Grade 9, 11, and 13 classes. He said he had received considerable support from the school administration.

Mrs. Melville teaches half time at Albert in the geography department. She teaches grades 9 and 10. She has seven years teaching experience and has been at the school for a year. She has a computer and printer at home, some programming experience, and is generally interested in computers. With the help and support of Mr. Devon, she has used simulations with the Grade 9 and 10 geography and environmental studies classes at both the general and advanced level.

1.3 Equipment

Six Apple computers (IIe and II+) are set up at one end of the geography preparation room. Each has a green screen and three have an additional colour monitor. There is one Apple printer in the lab and another in Mr. Devon's office. There is also a plotter for making maps in his office. Each computer has a single disk drive except the one hooked up to the printer, which has a double disk drive. At the printer station, a "Fingerprint" attachment allows the screen content to be dumped to the printer in the middle of a program. Mr. Devon first saw this device described in a computer magazine and subsequently ordered one. The computers are on tables with wheels and can easily be moved into the classrooms that adjoin the preparation room. Software is stored in Mr. Devon's office.

1.4 Software Used

The Grade 10 general classes do the simulations "Buflo" and "Air Pollution". The Grade 9's do the simulations "March Farm", "Oil Search", and "Mill". The Grade 11's do "Stratigraphy", "Weather Systems and Forecasting" (a tutorial), and "Demography 1 and 2". The Grade 13's do "Polymaps" to produce maps showing agricultural patterns, "Demographics" for demographic research, and may later do "Industrial Location".

2.0 COMPUTERS IN ACTION: MR. DEVON

2.1 How the Teacher Is Using Computers

Mr. Devon indicated in the initial questionnaire that he used "Polymaps" to produce maps showing agricultural patterns in Canada with his Grade 13's and "Weather Systems and Forecasting" with his Grade 11's. We visited his classroom to watch these programs in action. In the Grade 11 class (a fifty-five minute period in the morning on weather activity) six students used the computers in the computer lab adjacent to their classroom to complete a quiz that tested their knowledge of types of weather fronts. They were expected to complete the quiz quickly and move on to a tutorial on forecasting. Mr. Devon was in the classroom with the rest of the class who were working on related seatwork designed by Mr. Devon, including the development of a weather map. From time to time he would check the progress of the students working on the computers.

The first group of students to work through the quiz did not do as well as Mr. Devon had expected so they had to go back to a "review" routine rather than proceeding to the tutorial. As it happened, this quiz helped Mr. Devon discover that a key concept, "occluded fronts", had not been taught by the student teacher who had taught the unit. Mr. Devon was able to respond quickly: he gave a brief lesson on occluded fronts to those students who had not yet attempted the quiz. Subsequent students were able to complete the review quiz successfully, although none of them moved on to the tutorial segment while we were there.

The time students spent at the computer varied considerably: it was determined by their success at completing the test rather than by any set time allocated to them. Fewer students worked at the computer than anticipated because of the problems with the "occluded front" concept. We asked three students what they felt was the benefit of learning to use the computer. They agreed that it was a change to work in a new way, that the program was sensitive to specific errors they made and could provide help related to these specific points. They could also work at their own pace. The teacher was also available to help them since the rest of the class did seatwork while they were working on the computer.

Following the Grade 11's, the Grade 13's worked on digitizing map references so that they could plot a base map for the region of Canada that they were studying. Having produced the base map, they were to map agricultural uses using various data sources. For this lesson the teacher spent more time in the computer lab than previously. Students in the classroom were either collecting data from various sources to plot on their map or using a plotter to print their maps. The plotter had been brought in from Mr. Devon's office. In his computer use journal Mr. Devon reported that the production of base maps required a "great deal of teacher help because of program complexity and some software problems". Because of the time this activity takes, he has arranged for students to use the lab at other times when the computers were free.

We videotaped students at work on the "Weather" and "Agriculture" programs and had the students explain to us what they were doing. In the afternoon we asked Mr. Devon to comment on how he managed the two lessons we saw. He said that it took longer to do the weather work using the computer but it was worth it and he could not afford to worry about time. The advantage of using the computer program for him is that students can check what they know and the graphics are better than he can produce. What the computer cannot do is sense the level that the students are at and give little reviews to ensure that they know the details; it is not really sensitive to students in the way the teacher can be. With few machines, he does have trouble scheduling computer use. In order to get around this, he suggests that the students come into the lab in their spares. To reduce the problem of access he is planning to expand the space in the preparation room so that it can hold ten computers instead of six.

He has developed exercises to go with the computer work and this, he said, had taken a lot of time. The students work on the sheets he hands out and they use their textbooks. He gives "mini-lessons" when there is a common problem.

The purpose of the Grade 13 map work, which is worth about twelve per cent of the term's mark, was to lay a base for understanding the relationship between physical and economic factors and land use. Each student is responsible for creating maps of twenty counties and producing a composite taskmap. Mr. Devon said it was an exacting task. Since the students do not know how to use the map plotter, he has trained Steve, a student, to use it. Steve, whose marks are poor, has taken a keen interest in the computer-based work. Mr. Devon illustrated Steve's enthusiasm in the following anecdote:

> He's doing southern Ontario. He found out the total number of cattle in each county and he plotted it yesterday. So I said, "What does the map tell you?" He said, "Look at all the cows on here." I said, "That's fine, you know where all the cattle are but what if I asked you to subdivide that into dairy cattle?" He said, "Well, I can't do that." And so he missed that. He'll come back. He's found out how many dairy farms there are. "I've identified the number of farms that are dairy farms, hog farms, beef cattle and I've figured that out as a percent, so now I can show a percentage distribution of dairy farms and when you are working with a county that is this big and this big, at least I can compare them because it's on a percentage basis." Now he knows how to do it.

Mr. Devon's anecdote was intended to illustrate Steve's attitude to doing the mapping work and how the work was intended to stimulate an analytical approach to geography. Steve's response was a plus for Mr. Devon.

Mr. Devon responded to each student on the videotape by giving a bit of background so that we might understand who it was we were discussing and to help us make sense of what we had seen. He also told us about the students' feelings about being videotaped and the effect that that might have had on their work at the computer. We were definitely an event! He concluded by saying that he knew his kids very well and that he taught in such a way that "there's never been a barrier across the room". His comments about each student seemed to illustrate his focus on individuals.

When the mapping work was over, students handed in a report. Mr. Devon said that he did not use seminars or oral reporting because he did not think that "seminars did what you wanted them to do". He described how he moved from the data about land use to an economic analysis that helps students understand the data. He said that to help them complete their reports, he is available every afternoon until 4 o'clock, and the machines are available to them if they are free.

In order to find the time to do the mapping work Mr. Devon said that he had omitted a case study on the Niagara fruit belt using topographic maps and photo analyses. This study would not be necessary in any case, he said, once they had done the map study. This was a first time trial using the plotter and he said he had an open mind about what to do next time. He thinks he will use the same base maps next time and not have next year's students do them again. Instead, he would use them to enter data. This could save a lot of time; in a sense this year's students have contributed base maps for next year's students.

2.2 What the Teacher Is Trying to Accomplish

In our interview with Mr. Devon we sought his views about the benefits of computer-based work. The students learn to make decisions, he said. "They're initially learning to just make decisions and then realising, 'Hey, if I have a little more input, I can make a better decision!'"

He also stressed the capacity of the software he used to allow students to explore "what if" questions. "It is amazing to see these kids in Grade 13 take Canada's population of 1980 and project it to 2680 in twenty-year leaps. If they had to do that in their seat, well they would be bored. It opens up other kind of avenues that you used to be able to talk about before but you couldn't really investigate."

He had the same enthusiasm for computer work in the lower grades. "It is terrifying, you know, to see these kids plugging through a simulation. Suddenly somebody says, 'Oh, I see!' You go over and talk to them and they say 'Oh, yes, so I should have planted that hybrid rice because now I've got more pests.'"

In these programs students are able to try out their ideas and get an immediate response. In simulations many answers are often possible but students are accustomed to finding the "right" answer. They ask Mr. Devon, "Well, what's the right answer?" His response is to quiz them on their answer if they are on the wrong track -- "Why did you do that?" -- so that the students can work out for themselves where they went wrong. They'll then ask to try again: "Oh, I didn't read that closely enough. Can I come back and try it [on the computer] again?"

Mr. Devon had already used non-computer simulations but found computer-based simulations took some getting used to. As he said, "It was brand new -- noise in the classroom. . . . I can see for a traditional teacher where there is no discussion going on in the classroom -- simply question and answer -- that the noise would be tough." Students talking to each other is an important feature of the work for Mr. Devon. He does not want to have a complete computer lab of thirty machines because he wants the students to work together. Although he says that some people have expressed concerns that one person is going to do all the work when the students work in pairs, in fact "they share ideas with each other and are learning from each other".

Student tutors are also a benefit, although using tutors means that the teacher is cutting down his individual contact with students. It is by circulating, Mr. Devon said, that he knows when to bring the class together to discuss concepts with which the students are having common difficulty. Using the computer has, however, allowed him to work one-on-one with students and get to know the problems, which he said he preferred to standing in front of the class in the traditional way. This was, for him, a very valuable aspect of using computers.

> When you are teaching the class in the traditional way, you are never going to know what their individual needs are. . . You never know whether the students know what you are talking about unless you question them individually. I like the idea of being able to sit down with a small group of students who are working on a particular task while others are at the

> computer, or even being at the computer and helping them individually. You are acting as a tutor rather than a teacher at the front of the class. I don't want them to see me as the ogre at the front of the class. . . . I can offer them more of me than in a traditional role.

The enthusiasm that some students have shown for their computer work is something that Mr. Devon prizes. Grade 10 students are willing to help him run the Grade 9 "Oil Search" simulation and he has a number of Grade 13 students who are very keen on the computers. These seem to be the pay-offs for his efforts to run geography work on the computer. "It makes me feel human again. It's nice to have the kids come back. It's nice to see their interest. We spend an awful lot of extra time and it's nice to have the kids come back, as if to say 'we appreciate that -- can we do some more?'" Mr. Devon is encouraged by student interest in the medium and for him it is a welcome change in approach after teaching for twenty-two years.

2.3 Factors That Influence Computer Use

2.3.1 Equipment/Software. Mr. Devon has a variety of machines, which makes it difficult to do simple things like giving booting up or escape instructions. He is glad to have the six machines he does have but would like more colour monitors. He plans to extend the lab to ten machines so that, when appropriate, nearly all students could work on the computers in pairs. He would also like the back of his room to be modified to accommodate the machines so that he could see what was going on from the main classroom rather than having to dodge into the prep room.

Security for the equipment is a problem. Before the lab was established the machines had to be pushed into his office, but even now security is still a nagging concern.

We asked him whether, given the choice, he would choose a large monitor or another computer and he said he would choose the computer. We asked, why not use the large screen for whole class teaching? He admits that a large screen, if it could be seen, would help him give demonstrations of keyboard use but says that even a large screen would probably be "too small". "They can't see. I've tried it in the past and kids say, 'I can't see that, sir.' 'Well,' I say, 'you are too far back, that's why.'" To overcome the visibility problem, he produces on-the-spot, thermal transparencies of printout and projects those.

The problem he finds with purchasing software is that he often has to buy sight unseen and some of it is poor. Sufficient copies for six machines are another problem. Mr. Devon distinguishes between good software in a pedagogical sense and poorly written software: for example, he is prepared to tolerate some technical problems in software if the program is pedagogically sound. Mr. Devon said that good software should have good support materials: the general idea needs to be there, including worksheets. These worksheets are needed to ensure that the students learn something from simulations; otherwise it is just a game.

We asked him how he knew things were going well with the software. He said that he monitors students' progress through the various tasks in the program, and time limits help ensure that students get the work done. Preview of the material has helped reduce "glitches" during the lesson.

> You have to know all the branches of the program and you have to learn how to run it in the classroom as you go along, but you have to know the program cold. Every new program has to be learned over again. There is some transfer but they are so sophisticated you have to learn each one again. This is very time consuming. You have to understand all the options.

Adapting imported software to the Canadian context, which he considers to be crucial in geography, has also turned out to be time-consuming.

2.3.2 Teacher Preparedness. Mr. Devon mentioned two colleagues who share his interest in computer-based teaching and who had been helpful in getting him launched. They trade "how-to-do-it" advice. He also mentioned reading magazines, initially as a way to get going, and more recently as a source of software. He has established direct contacts with people who are writing about how to use computers in the classroom and with software developers.

Time to become familiar with the software has been a major factor in Mr. Devon's experience. "You've got to know every computer program inside out, because you've got to be able to answer the questions. . . . You've got to be dedicated to the program or the concept of using computers and be willing to devote that extra time." He gave the example of a teacher who had decided he wanted to use the computers but who had experienced problems because he was not sufficiently familiar with the software.

2.3.3 The Students. The students, he feels, have accepted the computer-based work but have not seen the need to read the instructions, either on the screen or in the workbooks. This is a matter of some frustration for Mr. Devon since the simulations depend on careful reading of the student guide materials. The failure of some students, especially the Grade 13 students, to take advantage of the availability of machines and of the teacher's help is also frustrating for Mr. Devon. The relative scarcity of computer time seems to heighten these issues. While Mr. Devon is prepared to see evidence of student interest in the fact that there are times when there are too many students after too few machines, he wonders whether students might use the system better than they do.

2.3.4 The Curriculum. Mr. Devon has chosen software that fits the geography curriculum he is following, but he finds that he has had to make adjustments because using the computer means that it generally takes longer to cover the topic. "If you are really concerned about covering a course of study you'll never be able to use computers in the classroom as much as you want to. It takes more time to use the computers than simply standing in front of the class and teaching the concept." As a consequence, activities he might have done in the past have been dropped in favour of the computer-based work.

He has had to modify some of the software to integrate it into the Canadian geographical milieu, although programs like "Weather Fronts" can be used as designed. He said that he has had to be flexible about his approach to the curriculum to be able to see how substitutions can be made to gain the benefits of computer-based work.

> We are not as tied to a set curriculum as we were in the past. It bothers me. If we are going to come up with standardized exams, it is going to make it rough for teachers who want to use computers in the curriculum, and yet the geography guideline draft suggests that we should be using computers in the classroom, but nobody knows how to use them.

He sees risks for teachers who want to be flexible about the curriculum: "If I were a teacher and not a head of department and became very interested in using computers and my head of department said 'Hold it! Are you on page 414?' What would I do?"

2.3.5 The System. Mr. Devon has received support from other colleagues, from his own administration, and from the board. He has actively pursued this support and invested considerable time in setting up the lab and locating, appraising, and modifying software. He decided what he needed and sought that out. This has involved him in writing proposals for pilot project support from the board, and in extensive cataloguing, rewriting, and curriculum development. The commitment has been major.

2.0 COMPUTERS IN ACTION: MRS. MELVILLE

2.1 How the Teacher Is Using the Computer

In the preliminary questionnaire, Mrs. Melville indicated that she would be doing "Oil Search", an oil exploration simulation, with her Grade 9 advanced level geography class as part of a unit on primary resources in a section on mining in the Canadian geography course. The simulation comes close to the end of the unit. Before beginning "Oil Search", Mrs. Melville took the students through the program in small groups. To prepare themselves for the simulation exercise, the students read the resource booklet accompanying the program and answered questions on the material. We arranged to videotape one of the simulation lessons.

In "Oil Search" the students work in groups. Each group starts with $900 capital that it uses to obtain information about the nature of the strata underlying land it owns. The students can ask for a seismic study, a rock density analysis, a core sample, and so on. When they feel that they have enough information, they can drill for oil. They can at any time decide to sell their oil in order to fund their search and drilling activities. Each group has a company name chosen by the students and programmed into the simulation by the teacher. Each member of the group is assigned a role in the company, although Mrs. Melville said that the students tend not to stick to them. The computer manages the activity by automatically calling up the next group's business when one group has finished.

For this simulation two computers were wheeled into the classroom from the adjoining preparation room that serves as the computer lab and where they are usually used. Working in self-selected groups of four or five, the students took turns working at the computers, three groups to each machine. The students had not done group work before in this course, and Mrs. Melville said that it initially took a while to get them to settle down to work. The groups that formed were not unexpected; they were friendship groups usually made up of members of the same sex. Two machines were enough for this simulation since students needed time at their desks to plot their next move. With more machines, group size could have been decreased, but Mrs. Melville felt that the groups she had worked well; all the students seemed to get involved. They helped each other do the work, including a new boy who was shown how to do it by his peers.

Mrs. Melville described how, on the first day, the noise level had been high: the students were excited about doing the work because they had heard about it from the previous year's students. By the third lesson, which we taped, the change-overs were smooth and relatively quiet.

This was the second time that Mrs. Melville had used "Oil Search". She had discovered for herself where all the oil was so she could help groups that were having difficulty finding it. We saw one group get behind because they insisted on drilling for oil before they had sufficiently analysed the rock where they planned to drill. They were going for oil, not data, but had not been successful. This was the third period and they had still not hit oil. At this point, Mrs. Melville felt she had to intervene. She asked them what they had been doing and guided them towards more fruitful approaches to exploration. Another group struck oil but were very subdued about it because they did not want to alert the competition. According to Mrs. Melville the groups were becoming very devious about letting on when they struck oil.

Mrs. Melville moved around the room talking to the groups. At the same time the groups were rapidly moving to the computers and back to their seats as their turns came up. Most were on for less than fives minutes at any one time. No print-out was involved but students recorded information from the screen onto progress charts and took it back to their seats for analysis. At the beginning, Mrs. Melville told us, they recorded everything but soon learned only to write down essential information. They were also supposed to graph their group's performance but most of them were leaving that until the end of the simulation.

Mrs. Melville described how initially she was frequently called upon to assist the groups. By the third session she was not called upon that often; the groups simply pressed on with the problem of finding oil. There was a lot of argument in one group, however, because they could not agree how to proceed. Mrs. Melville had to put them back on track. She told us that some groups took longer than others to get going. One group had difficulty plotting their graph and she went over to help.

She had been monitoring the group that was not doing well and went over to them to ensure that the students were able to capitalize on useful information that would soon lead them to oil. Finally they found where there was oil and much excitement was heard from the computer corner. They had found a trap and had to map exactly where it was. They would have to wait until the next day to drill and finally hit oil and Mrs. Melville wanted to make sure they did not lose the spot.

At one point there was a break in the program -- a "GO SUB" error -- and Mrs. Melville could not remember how to get out of it. She checked with Mr. Devon. It was the first time it had happened this year although it had happened the year before. Other problems she had had included students who arrived at class without their material, which they said they had either lost or forgotten, and students who did not bother to record the details of their exploration and then could not remember what they had done.

A couple of days later, when "Oil Search" was over, the class discussed what they thought about the simulation, and what they learned about the techniques of oil drilling and the economics of the process. Mrs. Melville taped that discussion for us. The students made a number of points about the real world connections of the simulation and how unrealistic the price of oil was in the program.

The questions, company records, and graphs were handed in to be marked, individually not as a group. Later the class was to be tested on specific facts. Mrs. Melville said that the previous year's students had done well on their assignments and on the test. Beyond the recall of specific facts, Mrs. Melville said that she was concerned to get them "to use their heads". On the Christmas exam, for example, there had been questions to interpret but she said, "It's difficult. Most of them haven't done this before. It's like pulling teeth with some of them, trying to get them to think."

We talked about Mrs. Melville's approach to teaching with computers. Student interest was an important element in her reflection on her experience. She felt that playing around with computers was a legitimate element of what students were doing but that time was a problem. The programs take longer to cover the same material and there is still all the other material in the curriculum to be covered.

She finds machine problems less of a difficulty than student behavioural problems: a crashed program is easier to deal with than some more ambiguous student problem in working at the computer. As she said, "You never know what the kids are going to do but the computer is pretty reliable."

Students helping other students she finds quite acceptable. It's good in her eyes because students will more readily accept their peers' help than the teacher's when they are stuck. The students know those amongst them who are knowledgeable about computers. Without these knowledgeable students Mrs. Melville felt that things would be more hectic: "When the students are first starting on a program and you've got six computers going, the problem is they do not read the information. If they would read the information they wouldn't have that problem. If one of the other kids comes over and says, 'Did you read that?', it's much more effective than if I say it."

Mrs. Melville sees situations that have to be sorted out, that are ambiguous, as hectic: she has to think about them more than she would a simple mechanical failure. The unexpected also makes things hectic, not expected things like the noise. As students become more familiar and confident with the computers, things do get less hectic but individual problems still arise. Why a student is in trouble still needs to be diagnosed.

Mrs. Melville feels that a crashed program does not waste as much time as students wasting time: program failure is seen as less a source of off-track time than students not paying attention to their work or not reading instructions. She says that seatwork takes some of the pressure off as it engages students' attention, leaving her free to deal with computer problems. However, seatwork for general level students has to be very carefully prepared. Hardware failure is serious but software problems are not so serious, partly because the software has been vetted and partly because she knows how to control it.

Mrs. Melville distinguishes between work slow downs in which she has to intervene and ones that may resolve themselves. She also distinguishes between situations in which students themselves need help and ones that might involve the computer or the software. Some things need immediate attention, you can't "just let it ride". Some situations press harder on the teacher to respond quickly. Others can be foreseen and attended to in advance -- for example, a long line forming at the computer: "You have to have something to fall back on," Mrs. Melville said. Students' demands for extra access, more computer experiences, are seen as the most demanding. She feels that day-to-day classroom management is easier to handle within the pre-arranged curriculum and classroom routines.

2.2 What the Teacher Is Trying to Accomplish

We asked Mrs. Melville what she thought the students were gaining from doing "Oil Search". She said that they were learning where you find oil and how oil is formed. Because of the simulation she felt that she was going into more detail than she normally would. She said that their better performance on content tests showed that they were learning the information. She also said that in Grade 9 they do not know what it is like to learn things in detail and the program helps them realize that it is important to do so. The work on oil is taken as an example of the mining industry and how minerals are found and extracted. Overall it is a study of how natural resources are used. It is the geographical concepts, not the decision-making element of the simulation that are the dominant feature.

Mrs. Melville feels that, for some students, working in groups is a good thing. She mentioned a girl who was repeating the year: "Now this girl did it last year, she's repeating. She knows the procedure and she has been good for them [the boys in her group] because they tend to be clowns. She's keeping them on track. It's a good responsibility for her. It's good for her self-confidence. She's guiding those two characters and they are getting somewhere."

In talking about her experiences with the computers, Mrs. Melville referred to the interest the students have shown in the simulations, in the way they are learning geography, not just in using the computers. She values the simulation approach because the students can try out ideas and see what happens. There are decisions to be made and these decisions can become the basis for discussion. The computer is not, therefore, an end in itself: "I think it is just one tool and I think it makes the students' learning more varied. I think they would get sick of computers if they learned everything from computers."

Mrs. Melville sees an opportunity in computer-based teaching for less able students to do well. She used the example of the Buffalo herd management program, "Buflo". She said that it was very straightforward, simply deciding how many animals had to be killed to maintain the herds. The students did reasonably well but for some of them it was a chance to say, "Well, finally I did something."

She came back to the interest the students have shown in the work. They all seem to like to do the computer-based work. As she said, "It makes you feel good when they enjoy doing it."

She did express concern about the carry-over from just learning the basic ideas to the environmental issues. Mrs. Melville teaches an environmental science course to general level students who had done a program on carbon monoxide. Although they showed a good grasp of the facts, she felt that the implications had been missed: "They certainly were able to give me what I wanted as far as the [work] sheets were concerned but I felt they should have been able to get a little more out of it than they did."

2.3 Factors That Influence Computer Use

2.3.1 Equipment/Software.. Mrs. Melville used "Apple Introduces Apple" to introduce students to the keyboard so that they would know what the various keys did. She stressed the need for user-friendly software that can be used with students who have a wide range of experience with computers, and also the need for appropriate seatwork materials. She said that with relatively few students on the machine, "you've got to have something else to keep them busy in between rather than just the computer program because it doesn't keep them busy." She finds that the materials that come with programs are often not directly useable.

She prefers to have glass over the monitor screens since the mess the students make on the screen with dirty fingers cannot be cleaned off screens of rippled plastic.

2.3.2 Teacher Preparedness. Mrs. Melville became interested in computers before teaching at Albert Secondary School and had already begun to look at software for geography so, from the beginning, her interest was in computer-assisted learning. She had been encouraged to used the simulations by Mr. Devon and had been given back-up support by him as she worked through them.

Her attitude to the computer is that it is one resource amongst many and it is subject to the same sort of decision making that goes on when these other resources are chosen. She is trying to learn from her experience, from how she used the program the first time through. What she says suggests that she has an open mind about both the computers' value and how well she is able to use them, but she is encouraged by student interest.

2.3.3 Students. We asked the students what they were learning from the simulation. They mentioned having to make decisions and learning the geology concepts. They also said that it was fun.

Like Mr. Devon, Mrs. Melville was concerned that students do not read the instructions:

> They see the program [and say] "That's great!" Put the disk in, "Tremendous, let's go!" It's a general problem and I think it gets better with maturity. It's a skill they can learn from computers. There is nothing wrong at a Grade 9 level from expecting a kid to be able to follow instructions, provided they are well-stated. That can be a problem too. [Then] if you don't do it, you don't get anywhere. The 2As are just as bad as the Gs. It's got to a point where students are saying to each other, "Did you read it?"

She feels that students have to learn the value of reading the material, although sometimes they have to be left to learn it for themselves. Some deliberately ignore instructions and "play" with the program. She gave the example of the farming game in which some students grew potatoes in southern Ontario for ten years and made a lot of money, but making money was not the point of the exercise. They did not learn the geographical lesson and so were wasting their time on the computer.

They also have to read the support documents carefully and find the information. Her main concern is with the response of her general level environmental science students to the programs she uses. Initially, the groups she used with the general level students were too big and now she has them working in pairs because, "they don't have the confidence with the machines that some of the other kids have." She gave an example of a student who was copying work because she was afraid of the machine, not knowing how to use it. Mrs. Melville gave her a tutorial and the girl overcame some of that fear. This confidence factor may be part of how pairs end up working together on the computer.

She said that she expected students to be able to give more perceptive answers to the questions in the "Air Pollution" module. She found that most of them could handle the factual material but did not take it very far, and she was concerned that the programs she was using might be asking too much of the general level students. She summed it up this way. "The kids seemed to enjoy it ['Buflo'] but I don't feel they got out of it as much as they could have. However, the A-level students did well. They were capable of drawing a conclusion."

Every group had a different plan and she said it was interesting to hear them justify their plan to other groups. However, in the follow-up lesson to the "Oil Search" activities, the students did not get very far in discussing their experiences, perhaps because they were being tape-recorded.

Working in groups at the computer presents only the occasional problem. Mrs. Melville related the story of a student who always hogged the machine. The students in his group had tried to deal with it themselves by dropping hints but these had been ignored. In the end, they complained to Mrs. Melville who had been unaware of the problem. She tried to stress the importance of sharing.

2.3.4 The Curriculum. Mrs. Melville is following a curriculum that is new to her, especially in environmental science, so she is feeling her way. She takes the view that any computer program she uses has to fit with what she is teaching, not that she has to adapt the curriculum to the computer resources she has. The computer is just one of the resources available -- a tool for teaching geography.

2.3.5 The System. Her use of computers in the classroom was suggested by the head of the department, by a wide variety of classroom-tested CAL materials, and by a computer lab with access to six machines. As well, supporting materials had been written for the software she did use, allowing her to blend seatwork and computer activity. However, she has had to think hard about how this system might best be used for general level students. It is not a problem peculiar to the use of computers, but there are undoubtedly special features to do with the kind of teaching she is using -- group work and questions that move beyond basic ideas to discussion -- that pose a challenge for any level of student but especially for general level students in the intermediate division.